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THE ROENTGENOLOGIC DIAGNOSIS OF INTRACARDIAC CALCIFICATIONS*

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INTRODUCTION

WE WISH to limit our use of the term "intracardiac calcifications" to a designation of those deposits of lime salt in the heart skeleton, in the region of the left annulus fibrosus and the mitral and aortic valves. Other calcareous deposits about the heart are mentioned and briefly discussed.

The presence of varying degrees of intracardiac calcification is a rather frequent autopsy finding, some authorities stating that microscopic lime deposits are found in all hearts over fifty years of age. We as roentgenologists are of course concerned only with those cases in which this calcium deposit is macroscopic and sufficiently large and dense to cast a shadow in roentgen study. The literature contains few reports of such shadows having been observed in the living, and rare indeed are those that have been correctly diagnosed. In presenting 3 such cases, in all of which the finding have been confirmed by autopsy, we hope to stimulate the roentgenologist's interest in this not uncommon condition and consequently, we feel sure, increase the number of correctly diagnosed cases. In doing so we present certain roentgen observations which we believe are characteristic and make certain recommendations as to the best methods of making such observations.

CASE REPORTS

CASE 1 (Hosp. No. 12992). J. McPh., aged forty-seven.

History. Frequent sore throats, no rheumatism, no syphilis. Always felt well with the exception of last year when he noticed shortness of breath on relatively little exertion. Cold two weeks ago.

Findings. Very slight cyanosis. No edema. Marked systolic thrill over the aorta and systolic and diastolic thrill over the apex. The apex beat is of increased resistance, in the 6th intercostal space, 10 cm. to the left of the median line. Blowing systolic murmur at the apex transmitted to axilla followed by short diastolic murmur. Rough, harsh systolic murmur over the aorta, best heard in the 3d and 4th intercostal space to the right of the sternum, transmitted to the carotid arteries. Heart rate 80, regular. Second aortic sound not heard. Pulse wave in the radial arteries rather slowly rising but of normal filling. Blood pressure 114/78. Red blood cells 3.9 million, hemoglobin 13 grams. Blood chemistry, kidney function test, urine, eye grounds, normal. Electrocardiogram: Bundle branch block (Fig. 1).

Roentgen Findings. Moderate enlargement of the heart, transverse diameter 14.2 cm., internal chest diameter 24.8 cm. Configuration, mitral

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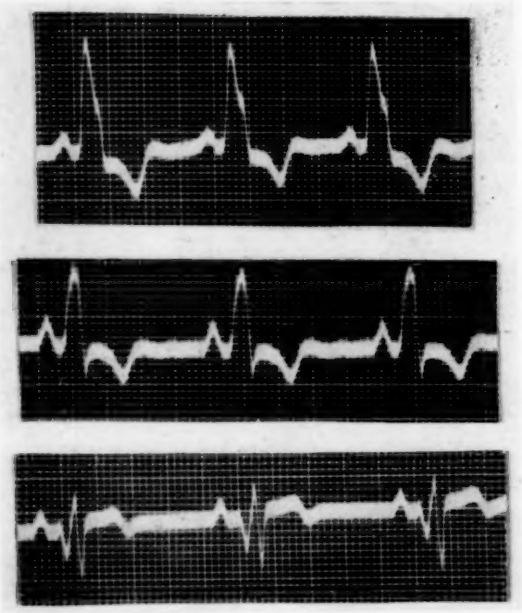

FIG. 1. Case 1. Showing typical bundle branch block.

and aortic (Fig. 2). In the oblique view a moderate enlargement of the left atrium is noted. The calcifications in the region of the valvular orifices can be seen roentgenoscopically in the straight anterior projection if one's eyes are thoroughly adapted and the shutter closed down to a minimum size. In this projection the calcifications lie slightly to the left of the midsagittal plane. When the patient is turned to the right anterior oblique projection at about 10° to 15°, the calcifications within the heart silhouette are seen very plainly, just to the left of the spine shadow. At a slightly greater angle of obliquity the shadows become sufficiently definite to be analyzed as to their movements and it is noted that the movement is somewhat elliptical, forward and downward during systole and backward and upward during diastole. When the patient is examined in the left anterior oblique position the movement is along a rather straight line in the longitudinal axis of the heart, slightly backward as well as downward during systole and exactly in the reverse direction during diastole. The excursion of this movement is between 8 and 10 mm. It is noticeable that the systolic excursion is more rapid than the diastolic one. The diastolic excursion is interrupted by a very short, steplike, slowing up in speed. The areas of calcification appear foreshortened in the anterior projection and in slight rotation to right anterior oblique projection. In the left anterior oblique projection (and right posterior oblique projection) the greatest spread of the calcifications is noted. In direct lateral projection excursion of the calcifications amounts to as much as 1.5 cm. It is noticeable that the corresponding systolic-diastolic excursion of the borders of the cardiac silhouette is only about 3 mm. (Figs. 3, 4, and 5). Lung fields without congestion.

The findings are interpreted that the most caudal calcifications are at the mitral orifice around the insertions of the leaflets and the most cephalic calcifications are at the aortic orifice.

Clinical Diagnosis. Etiological: Atherosclerotic degeneration. Anatomical: Ventricular hypertrophy, left more than right. Moderate degree of enlargement of the left atrium. Calcareous degeneration of the mitral ring and of the aortic valves. Mitral regurgitation and stenosis; aortic stenosis. Physiological: Regular sinus rhythm; left bundle branch block (due to interference of calcareous deposits with the conductive system). Functional: Absence of cardiac failure.

Later on the patient developed cardiac failure and died five months following the first examination.

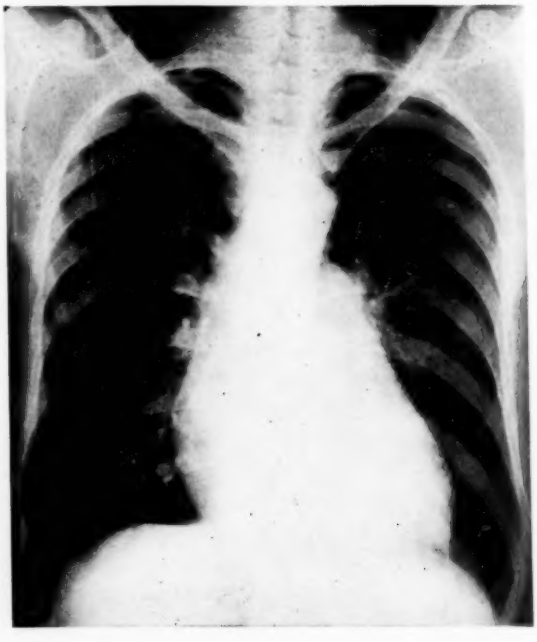

FIG. 2. Case 1. Seven-foot film, 1000 ma., 85 kv., 1/30 second. No calcification is noted. Absence of signs of congestive lung failure.

Post-Mortem. No. 12104. Heart: Weight, 775 gm. Dilatation and hypertrophy of all chambers. Aortic stenosis and insufficiency with calcification. Mitral stenosis and insufficiency with calcification. Calcification of small area of left ventricle. Fatty degeneration. Congenital narrowing of orifice of right coronary with hypoplasia of latter. Microscopic: Acute myocardial degeneration most marked on right side. Fatty degeneration of myocardium. Aorta: Early atheromatous degeneration. A study of the bundle will be undertaken.

Fig. 3. Case 1. Rotalix tube, 3-foot distance, 400 ma., 65 kv., 1/20 second. Left anterior oblique position. The area of calcification corresponding to the mitral ring is clearly shown.

The right auricle is dilated. The tricuspid leaflets show no thickening or abnormalities. The chordae tendineae are not thickened. The right ventricle is moderately dilated. The endocardium is smooth and glistening. The pulmonary cusps are normal. The pulmonary artery shows no sclerotic changes. The left auricle is dilated. The endocardium is smooth and glistening except for an irregular, yellow, calcareous deposit 3×0.5 cm. which extends upward equally to the right and left from the mesial junction of the anterior and posterior leaflets of the bicuspid valve, being a continuation of a similar process in the left ventricle. The endocardium is thinned out and absent over this area. The bicuspid orifice is very narrow measuring only 5.5. cm. The leaflets are

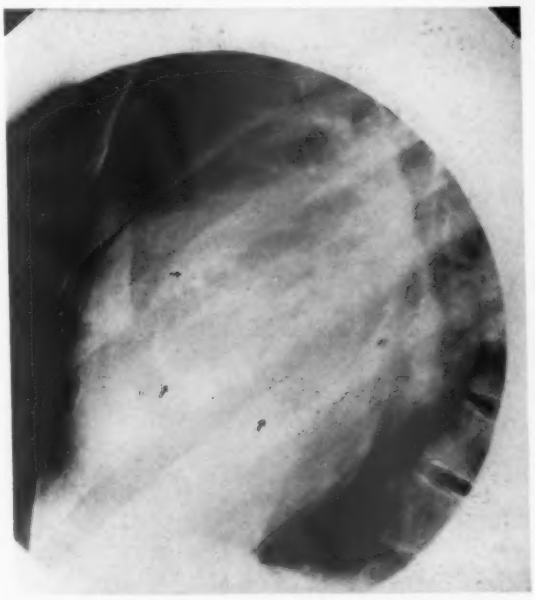

Fig. 4. Case 1. Same technique as in Figure 3. Almost lateral position of the patient, right to left. The lower area of calcareous deposits corresponding to the mitral ring and the upper area of calcareous deposits corresponding to the aortic valves are demonstrated.

thickened because of the calcareous deposit previously mentioned. The chordae tendineae are thickened. The left ventricle is both dilated

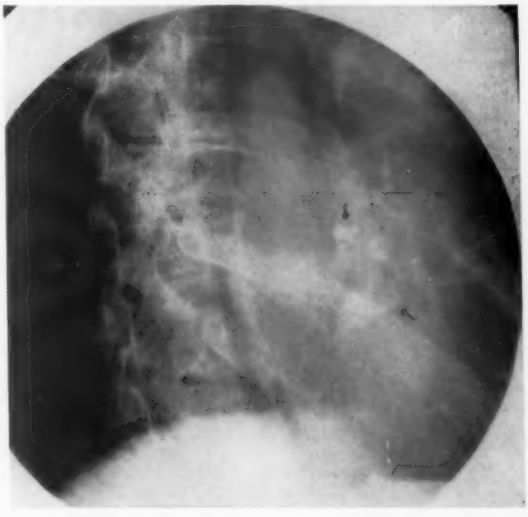

Fig. 5. Case 1. Same technique as in Figures 3 and 4. Right anterior oblique position. Moderate enlargement of the left auricle is noted. The calcification of the mitral and aortic area is demonstrated.

FIG. 6. Case I. The heart as seen from the left side. The mitral valves (below) are much thickened; the aortic cusp is fused with the interventricular septem; at its edge a nodular swelling is noted. The aortic valves (above) are much deformed and thickened.

and hypertrophied; the myocardium shows evidence of some fibrosis. The endocardium is smooth and glistening throughout except for a beaded, rough, yellow, irregular band of calcareous deposit near the root of the aorta originating about 1 cm. below and slightly to the right of the membranous portion of the septum, thence continuing posteriorly and to the left to become continuous with the process previously described in the left auricle. It extends for a distance of about 4.5 cm., is 6–7 mm. wide and projects about 4 mm. out from the surface. The endocardium over this area is atrophic and absent. The aortic orifice is stenosed, measuring 5.5 cm. The cusps are rigid, thickened and deformed by extensive, beaded, calcareous and bony deposits extending along to their ventricular and aortic attachments, being most marked at the junction of the right and posterior cusps and next at the commissure between the left and right. All are fused and extensively thickened. The sinuses of Valsalva are encroached upon by deposits of calcium. The left coronary orifice measures 5.0 mm., the right coronary orifice 1.5 mm. in diameter and appears congenitally hypotrophic. Aorta: The intima is smooth showing only a moderate number of raised atheromatous plaques most marked around the origin of the former ductus arteriosus.

Figures 6 and 7 are photographs of the post-mortem specimen and Figure 8 is a roentgenogram of the post-mortem specimen.

CASE II (Hosp. No. 27744). J.M., aged forty, coal miner.

History. No rheumatism; cough. Palpitation and pain over precordium.

Physical Findings. Wheezing respiration, marked cyanosis, dyspnea, edema, emphysema, pneumoconiosis. Systolic murmur at apex. Heart rate 78, regular. Blood pressure 120/80; E.K.G.: Partial auriculoventricular heart block, P-R interval 0.24 sec. No definite axis deviation.

FIG. 7. Case I. The same view as Figure 6 with greater magnification.

Roentgen Findings. Moderate enlargement of the heart; orthodiagram, transverse diameter 16 cm., internal chest diameter 27.4 cm. Configuration mitral with prominence of the pulmonary conus and small aortic knob. Branches of the pulmonary artery enlarged. Roentgenoscopy reveals area of calcification, inside of the heart, visualized in slight right anterior oblique position. The movement is of a dancing, elliptical type, at least 1 cm. in excursion. This calcareous deposit was thought to correspond to the mitral ring. Lungs show fibrotic changes, calcified nodules in both apices.

Post-Mortem. No. 4834. Heart: 620 gm. in weight. Hypertrophy and dilatation of the right chambers. Left ventricle almost normal in size. Defect in the interatrial septum 3.5 cm. in diameter. Aortic valves show slight thickening along the margins. Tricuspid valves moderately thickened. Pulmonary valves and mitral valves markedly thickened, the latter with calcification extending from the middle of one leaflet down well into the muscle with the appearance as though bone were forming there. This calcification also extends into the left ventricle for a distance of 3 cm. The other leaflet is greatly thickened and calcified along the border. Pulmonary artery markedly dilated, aorta hypoplastic. Pericardium normal.

Fig. 8. Case 1. Roentgenogram of the post-mortem specimen. Its position corresponds approximately to that of Figure 6. Extensive calcification of the mitral and aortic valves is noted.

Fig. 9. Case II. Roentgenogram of the post-mortem specimen. Calcification of the mitral valves is noted.

Microscopic Findings. In the areas of calcification about the base of mitral valves, which calcification extends into the muscle a short distance, there is actual bone formation with fatty tissue and myeloid cells. Generally there is hypertrophy of muscle fibers of the myocardium.

A roentgenogram of the post-mortem specimen is shown in Figure 9.

Case III (Hosp. No. 53281). W.S., aged fourteen.

History. Repeated attacks of rheumatic fever since the age of four. Cardiac failure for past year.

Physical Findings. Cyanosis, edema, short-

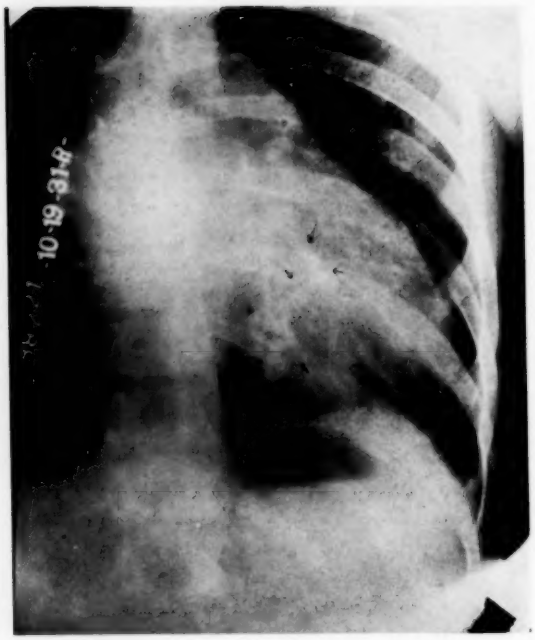

FIG. 10. Case III. Slight degree of right anterior oblique rotation, showing extensive area of calcification.

ness of breath. Apical impulse in 6th left intercostal space, 13 cm. from midline, heaving. Presystolic thrill at apex. Long blowing systolic murmur at apex; systolic and diastolic murmur at aortic area. P_2 accentuated. Heart rate 110, regular. Blood pressure 110/50; E.K.G.: Regular sinus rhythm, no axis deviation, normal P-R interval.

Roentgen Findings. Heart enlarged to the left; transverse diameter 13.9 cm., internal chest diameter 19.7 cm. (orthodiagraphic); configuration mitral. Left atrium enlarged as seen in oblique positions. In the anterior view, to the left of the spine from left above to right downward, 4 cm. in length, 1 cm. in thickness, there is a band-like area of calcification (Fig. 10). In the right anterior oblique position it appears foreshortened, in the left anterior oblique position lengthened. In all projections it is seen inside of the heart. In the anterior view this area is seen to move downward and to the left with systole and upward and to the right with diastole, having at the same time a slight rotary motion. Amount of excursion 1.5 cm. at least. In the right anterior oblique position it shows a lever motion; the excursions appeared somewhat larger. Diagnosis: Calcification of the heart at the base.

Post-Mortem. No. 4596. Heart: 340 gm. in weight. Hypertrophy and dilatation. Mitral stenosis, aortic insufficiency, mild chronic endocarditis of the tricuspid valves. Chordae tendineae thickened and opaque. Both mitral and aortic valves are shortened, thickened by hyaline tissue and calcareous deposits. These deposits extend from the mitral valves into the septum and left ventricle. Auricular and ventricular endocardium thickened. Pericardium: There is slight roughening around the vena cava on the right side where a few thin papillary adhesions extend toward the heart. Microscopic findings: Perivascular scars through heart muscle but no Aschoff bodies. Valves thickened and fibrous. This thickening is continuous with the calcification at the base of the valves and myocardium, surrounding which the muscle fibers are atrophic by compression and merge with the area of calcification through a proliferation of fibrous tissue.

A roentgenogram of the post-mortem specimen is shown in Figure 11.

PATHOLOGY

For an understanding of the roentgenological and clinical aspects, a knowledge of the underlying pathology is necessary. As a result of the investigations of different authors (Mönckeberg; Dewitzky; Ribbert;

FIG. 11. Case III. Roentgenogram of the post-mortem specimen. Extensive calcification about the mitral valves is noted.

Geerling; Margolis, Ziellessen and Barnes; Giese; Martens; and others), the following conception can be offered.

The skeleton of the heart consists of connective tissue which is interpolated between atria and ventricles and which serves for insertion of the atrioventricular valves as well as for the aorta and pulmonary artery. The main parts are the septum membranaceum, trigona fibrosa and the annuli fibrosi. The right trigonum is at the right, the left at the left aortic leaflet. Between both trigona extends the aortic cusp of the mitral valve. The fibrous annuli of the atrioventricular valves consist of a tendinous connective tissue, poor in cells, with very few elastic fibers and very dense collagen fibers. The trigona fibrosa contain collagen fibers with many nuclei. The aortic valve consists of three layers: the inner one, corresponding to the ventricular endocardium is rich in elastic fibers, the intermediate layer has loose connective tissue, the outer layer with dense collagen fibers extends from the media and adventitia of the aorta.

In a considerable number of aging hearts, dystrophic changes in the skeleton of the heart are found. They are known but not sufficiently appreciated. These processes may reach such a degree as to produce disturbances in function. This degenerative process, which mainly affects the left annulus fibrosus and the aortic valves, takes place in a tissue which is poor in nuclei. The trigona fibrosa, which are rich in nuclei, are rarely and only secondarily affected. The right side annulus fibrosus, tricuspid or pulmonary valves are extremely rarely affected. The stages of this degenerative process are fatty degeneration, necrosis, atheroma, calcification. Fatty degeneration in the annuli fibrosi and in the valves is quite commonly seen by microscopic examination after the age of thirty. Necrosis may take place without preceding fatty degeneration. Lime salt deposits are found microscopically in practically every heart after the age of fifty.

I. *Annular Sclerosis*. Here the main mass is in the musculature, protruding and stuffing the base of the valves inward, most commonly seen in calcification of the mitral ring. The calcification usually starts in the posterior third of the mitral ring and extends forward and progresses from the septum: (*a*) into the mitral valves, so that finally a completely calcified ring around the ostium of the mitral valve may result; (*b*) below the right trigonum fibrosum, within the musculature of the lower portion of the septum membranaceum. In advanced cases, the calcareous deposits may reach the size of the small finger and may produce valvular lesions. The amount of lime salt which has been extracted has been often 3 to 4 grams, in extensive cases up to 8 grams. The atherosclerotic process in the mitral valves is always more pronounced at the ventricular surface of the valve.

II. *Aortic Valve Sclerosis*. The involvement affects primarily the aortic ring, at the valve roots. In the first stage of the disease only the outer layer, at the site of the sinus of Valsalva is diseased. Calcification then extends into the leaflets, into one of the commissures, bulges into the valve sinuses or forms radiant or circular buckles within the valves themselves. Lime salt deposits may fill up the sinus completely. From there it may progress into the ventricles, producing spur-like formations below the endocardium. They are most usually found extending from the posterior aortic valve into the large leaflet of the mitral valve. An extension from these valves to the pars membranacea or muscular portions of the septum is much rarer. Calcification in the aortic valves may occur in combination with calcification in the annulus fibrosus or may be entirely isolated. The valves themselves appear thickened with an irregular surface and fused at the commissures. The places of fusion may shrink considerably. This type leads, as a rule, to stenosis. The coronary arteries reveal in many instances some degree of sclerosis, but the degree of coronary artery disease is not greater than one would ex-

pect to encounter in a group of normal patients of the same age. Calcareous infarction of the papillae of the kidneys has been commonly found (Giese), and the combination with hyperostosis of the frontal bone or calcification of the intervertebral disc is not unusual (Martens).

Calcification of the aortic valves is also seen in syphilis. Here we are dealing with an inflammatory process with scar formation. Not the roots of the valves are affected but the rim of the valves. The process descends from a luetic, diseased aortic wall and the calcification is secondary to atherosclerosis. The other condition where calcification may take place is endocarditis. Endocarditic changes may affect the first, inner layer of the valve directed toward the ventricle. Here calcification is seen at the surface and in thrombi. The degenerative type of calcification takes place in the third, i.e., outer layer. Calcification of the mitral valves is also seen in endocarditis but here the process also leaves the roots free and affects the edges of the valves. It is mainly localized in the parts of the valves toward the atrium; however, it may be noted that in the degenerative type of calcification, calcification of the chordae tendineae is also found.

The occurrence of calcification of the mitral ring and of the aortic valves is not uncommon. In Martens' series of 1000 autopsied cases, 500 male and 500 female, predominantly older people, calcification of the mitral ring, as felt by palpation, was present in 8.7 per cent. Giese found calcareous deposits in 64 out of 700 cases. In 30 cases there was pure annulus calcification. In 2 the aortic valves only were affected. In 22, a combination of both was found. In 8 cases inflammatory changes were also present. In 12 cases calcification of the annulus produced a valvular lesion of the mitral ring. Margolis, et al. report 42 autopsied cases of calcareous aortic valve changes observed within eight years.

Out of the older literature, well illustrating the extension of this process may be cited the case of *Topham:*

Man aged seventy-one, with a clinical picture of chronic cardiac insufficiency. Post-mortem findings: Heart 18¾ ounces in weight, evidence of advanced myocarditis with fatty degeneration. Flattened plates of bone are found, crossing the heart, embedded in the cardiac tissue in the lines of the auricular-ventricular grooves. One is 4×1 inch, widening up to 2 inches at its right portion, along the right auricular-ventricular groove. At the left side two smaller fragments are found each about 1×1½ inches. Aorta and orifices of the coronary arteries appear normal.

As to the location of calcareous deposits in the heart the following subdivisions are given: (1) pericardium; (2) coronary arteries; (3) heart muscle; (4) calcification of annulus fibrosus; (5) calcification of endocardium; (6) within an aneurysm; (7) in thrombi; (8) in tumors.

The discussion of calcifications in the pericardium is not within the scope of this paper and they are mentioned only for purposes of classification and differential diagnosis. Their frequency is probably some justification for their being the usual mistaken diagnosis in cases of calcification of the annulus fibrosus. Coronary artery calcifications, calcifications in aneurysms, thrombi and tumors are similarly dismissed. Since calcifications in the heart muscle and endocardium are rare and little known, with their pathology little understood, interesting case reports from the literature are added with the understanding that the deposits of lime salt were large enough so that the roentgen diagnosis should be possible in similar cases.

Calcification Predominantly Located in the Endocardium.

1. Parietal endocardial callosities are seen in the presence of congenital stenosis of an ostium, below the site of the stenosis. Here the endocardium is diffusely thickened and one finds in the deeper portions smaller and larger areas of calcification. Examples:

Pal: Patient aged forty-nine. Diagnosed as congenital heart disease. Post-mortem findings: Dextrocardia, concentric hypertrophy of the left ventricle. The conus of the aorta is much narrowed down and there is in this area callosity with lime salt deposit extending up to the valves. The aorta has two valves.

Bret and Blanc-Perducet: Man, aged fifty-eight. Findings: Intensive systolic murmur over the aorta transmitted to axilla, back, lumbar region, clavicles and right carotid artery. No thrill. Post-mortem findings: No changes in the aortic valves; below their level are two calcified nodular areas each 8 mm. in size, producing a glottis-like stenosis.

2. As a probable late result of wall endocarditis, the following case may be cited:

Oppenheimer: Man, aged forty-four, who had mitral stenosis and auricular fibrillation. Post-mortem findings: Marked right-sided hypertrophy of the heart. Extensive calcification in the left atrium with the exception of the auricular appendage and the auricular septum. The process affected the inner coat leaving the striated musculature untouched. The hard plate itself was of hyaline degenerated connective tissue much of which was calcified and had partly undergone an osteogenic process.

3. In the course of bone destruction and calcium metastasis.

V. Leyden and Davidsohn, Lazarus and Davidsohn: Girl, aged nineteen. Post-mortem findings: Extensive sarcoma of the dura mater associated with advanced diffuse destruction of the tables of the skull. Heart normal in size. Lining of the left auricle covered with calcareous plaques. Microscopically: Only the endocardium is affected. Also extensive calcification in lungs, kidneys and stomach. *Versé:* Man, aged twenty-five, with chronic myeloid leucemia of two and a half years' duration. Post-mortem findings: High degree of calcareous deposit in lungs, kidneys and heart. The heart weighs 400 grams. In the left auricle there is diffuse calcification of the endocardial and subendocardial connective tissue reaching down to the valve ring. Some calcareous deposits are found in the right atrium near the ostium of the inferior vena cava. Multiple calcification in the media of the lung veins.

Calcification Predominantly Located in the Myocardium.

1. In septic, toxic and pyemic conditions usually with renal involvement. Examples:

Coats: Case 2. Case of pyemia with abscesses in lungs and kidneys, the heart normal in size. In the wall of the left ventricle numerous pale, gritty deposits are arranged in patches "up to a 6-penny piece," also in elongated streaks. This condition is present in the surface layers and affects the anterior and posterior wall of the left ventricle. Microscopically: Broken up muscle fibers with calcareous deposits proved by chemical examination. *Briddon and Hardrichs:* Man, aged twenty-six, with attacks of rheumatism in the past and signs of cardiac failure. Post-mortem findings: Adhesive pericarditis. In the heart itself, a number of hard nodules are found from pea to hickory nut size. A section of one shows a cavity with pus and with calcified walls. The smaller ones have the consistency of cartilage. *Roth:* Man, aged twenty-nine. Chronic traumatic osteomyelitis of the left hand lasting for one month, followed by sepsis and marked renal involvement. Post-mortem findings: Heart weight 342 grams. Scattered throughout the ventricles, more through the left than the right one, multiple, fine calcareous granules deposited in degenerated muscle fibers. Nephritis and thrombosis in kidneys.

2. Calcium metastasis in ostitis fibrosa cystica with renal involvement.

Siebenmann: Man, aged thirty-six, with kyphosis, paresis of lower extremities, anemia, fracture of the humerus and cachexia. Post-mortem findings: "Osteomalacia" with multiple bone cysts. Heart weight 287 grams, containing a large amount of lime salts in its arteries, veins and muscle fibers, very little in the intramuscular connective tissue. The distribution is such that obviously impregnation took place from the blood vessels. Calcium metastasis in stomach, kidneys, lungs and liver. Granular kidneys. *Penecke:* Man, aged thirty-eight, with chronic nephritis and osteitis fibrosa cystica. Post-mortem findings: Granular kidney. Calcareous deposits in the muscle of the left heart in the region of the auricle, apex of the ventricle and ostium; furthermore, in arteries, thyroid, kidneys and spleen. Parathyroid tumor present. No calcification in the large vessels present.

The following case, also belonging here, did not show typical calcium metastasis:

Hubbard and Wentworth: Man, aged twenty, with chronic nephritis and extensive calcification of peripheral arteries as shown by roentgen ray and by examination of excised artery. High blood calcium. Death eleven months later. Post-mortem findings: Osteitis fibrosa of the skull, ribs and vertebrae with two large parathyroid glands and a small adenoma in one. Severe interstitial nephritis. Calcium deposits in the wall of the left auricle. Calcification of the wall of the small peripheral arteries. No calcium deposits were found in organs usually affected by metastatic calcification, such as lung, kidney, stomach, liver, spleen.

Myocardial degeneration may be followed by rather extensive deposition of lime salt. Examples:

Heschl: A woman, aged thirty, with advanced Bright's disease and associated marked cardiac involvement. Post-mortem findings: Advanced myocardial degeneration with multiple, linear, streak-like areas of calcareous deposits in the heart muscle.

Microscopically: Granules of calcium carbonate within broken-up heart muscle fibers. Also sclerosis of the aorta and coronary arteries and chronic granular kidney with atrophy of the glomeruli. *Hinrichsmeyer:* Man with cardiac decompensation for two months. Post-mortem findings: Sugar icing of the endocardium of the left ventricle; calcified nodules of stony hardness in the region of the anterior papillary muscle, smaller nodules, the size of a pea, in the myocardium near the apex and a calcified ridge with stellate radiations in the endocardium of the left ventricle, a calcareous patch, the size of a 2 mark piece, in the wall of the left atrium. In addition, atheroma and dilatation of the aorta and a high degreee of coarctation of the aorta.

The etiology is not clear in the following case reports:

Simmons and Watson (1784): Man, aged sixty-seven. Pericardium very thin and "obliterated with heart surface." Ossifying process along the diaphragmatic surface of the heart extending from the bases to the apex of the heart, branching out irregularly through the substance of both ventricles and over the greatest part of the auricle and for some way around the bases of the heart, not projecting into the auricular or ventricular cavities. *Renauldin* (1806): Man, aged thirty-three. Post-mortem findings: The whole left ventricle is petrified, trabeculae like stalactites. The grains are increasing in size in the deeper layers. The right ventricle and the large vessels are without these changes. The temporal, maxillary and part of the radial arteries are ossified. *Diamond:* A six and a half months' fetus. Post-mortem findings: Roentgenogram of the heart showed linear calcareous deposits in the right auricle and irregularly scattered calcareous deposits in the walls of both ventricles. Microscopic examination: In the right auricle, practically all the muscle fibers are replaced by lime salt. Similar but less pronounced changes in left auricle and left ventricle. Primary degeneration of muscle fibers with calcification.

Functional Effects of Valve Calcification. Calcareous deposits may cause functional lesions of the heart valves. For practical purposes, only the mitral and the aortic valves are to be considered. Calcareous buckles of lime salt deposits in the mitral valves may produce mitral valvular lesions. Calcareous buckles in the aortic valves keep the valves wide and stiff. There is not much shrinking because there is very little granulation going on around the calcified foci and furthermore, the lime salt impregnation counteracts shortening of the valves. Incompetency or stenosis may be of long duration but absence of symptoms of cardiac disease for a considerable time is quite common. The etiology remains mostly obscure. Two typical cases may be cited here from the literature:

Boinet: Patient aged thirty-six. Clinically: Mitral insufficiency and probably aortic stenosis. Post-mortem findings: Corresponding to the mitral valve is a calcified ring producing stenosis and insufficiency. An area of calcification 2 cm. in length and 1.5 cm. in thickness extends toward the aortic valves. Aorta is without pathology. *Firket:* Patient aged seventy-four. Clinically: Mitral insufficiency and cardiac hypertrophy. Post-mortem findings: Enormous heart, interauricular septal defect, 1×1.5 cm. Calcareous degeneration of the aortic valves, producing stenosis and slight insufficiency; calcareous degeneration of the mitral ring, producing marked stenosis and also insufficiency. (This case can be well compared with our Case 11.)

Recently Christian has referred to 21 cases of aortic stenosis due to calcification of the cusps, with post-mortem reports. Occurrence is chiefly in males, relatively late in life. There is presence of a thrill and harsh systolic murmur often accompanied by a softer, more blowing diastolic murmur. There is considerable hypertrophy of the heart. The pulse is often characteristic for aortic stenosis with a normal or decreased pulse pressure. Autopsy shows the heart to be increased in weight, average 680 grams. The aortic valves are greatly narrowed and thickened, the cusps often interadherent to each other with masses of calcification. The other valves are normal or only dilated.

The location of this process of calcareous degeneration may cause interference with the specific conduction system of the heart. Mönckeberg has pointed out that the danger for the bundle in presence of annular sclerosis is not so marked because the loose fibrous sheath of the crus commune does not participate in the sclerotic changes of the surroundings but remains loose and rich in cells, thus enabling the bundle to escape. This protection ceases to be of help if the dimensions of the calcified surroundings become too extensive or if the sheath becomes sclerotic also. The cases of Mönckeberg

(1908—Case 2; 1917—Cases 1 and 2), Oppenheimer and Bishop, Geerling (Case 6) may serve as examples of anatomical interruption of the conductive system due to calcareous deposits. Out of 17 cases with electrocardiographic report (Margolis, Ziellessen and Barnes), one case showed an incomplete bundle branch block. Out of 16 cases with electrocardiographic report (Christian), a delayed atrioventricular conduction time was present in 3 cases, bundle branch block in one case. One of our cases shows bundle branch block, the prolonged atrioventricular conduction time in the other could be explained by an active rheumatic heart condition also. Case 1 of Saul also had a prolonged atrioventricular conduction time.

ROENTGENOLOGIC EXAMINATION

Calcareous deposits within the heart are best demonstrated by roentgenological examination, both in the living and in post-mortem study. Simmonds (1908) demonstrated on roentgenograms of post-mortem specimens calcified coronary arteries, calcification in an aneurysm of the heart, calcification of the pericardium and in 5 cases calcification of the mitral ring, mitral and aortic valves. These were partly of the purely degenerative type, partly following inflammatory changes. The oldest one in this group was eighty, the youngest one thirty-five years.

It requires a special technique to detect these areas of calcification in the living; in the Margolis, Ziellessen and Barnes post-mortem series of 42 cases with calcareous deposits in the aortic valves, 28 had been submitted to roentgen examinations during life; in no case was the diagnosis made, in 3 cases calcification of the aorta had been observed. One of Geerling's cases showed at the post-mortem examination calcification of the annulus mitralis with a diameter of 10–12 by 4 mm. The roentgenogram taken during life did not demonstrate this extensive change.

Before discussing special features of the roentgen examination, the cases hitherto observed may be cited. The first case reported in the literature, observed but not correctly interpreted during life is by *Klason* (1921).

In a man, aged seventy-seven, the roentgenological examination showed within the heart shadow a dense pulsating shadow the length of the small finger corresponding to the border of the left auricle and ventricle. Calcification of the pericardium was considered but post mortem showed calcareous deposits in the posterior portion of the annulus fibrosus of the mitral valve. The valves themselves were not calcified. *Cutler and Sosman* (1924) described 2 cases in both of which calcification of the pericardium was present also. Case 1: Woman, aged twenty-six, with rheumatic fever at sixteen. At this time friction rub and systolic thrill and harsh systolic murmur at apex. Short diastolic murmur along the left border. Precordial bulge. Almost continuous thrill over pericardium; systolic and diastolic murmur over heart. Auricular flutter. Roentgen examination: Large heart with prominence of conus arteriosus, areas of increased density in the region of the auricular-ventricular septum are noted suggesting calcification. Post-mortem: Complete obliteration of pericardial cavity with calcification scattered over the heart surface. Heart plus pericardium plus attached parts of pericardium 1,020 grams in weight. Interventricular septal defect. Anomaly of tricuspid valves. Insufficiency and stenosis of tricuspid valves. Stenosis of mitral orifice. Stenosis of pulmonary orifice. Calcification of pericardium, of papillary muscle, of pulmonary valves and of mitral valves. Case 2: Man, aged forty-three, with increasing dyspnea, cyanosis and clubbing. Roentgen examination: Heart increased in size, fixation of apical impulse, calcification of pleura and pericardium. Death following operation for adhesive pericarditis. Post mortem: Calcification of pericardium, pleura, peritoneum, surface of liver and spleen. Large masses of calcified material 2×1 cm., replacing the myocardium just below the auricular-ventricular groove. At the base and anterior segment of the mitral valves there is material of bony hardness present. The first case of pure annulus calcification, diagnosed as such during life by roentgen rays and proved by post mortem was published by *Fleischner* (1925). Woman, aged eighty-five. Roentgen examination: Heart normal in size. To the left of the median line there is a shadow of lime salt density, having the thickness of the small finger, and showing movements rhythmical with the heart action. It is near the posterior wall of the heart and inside of the heart. Diagnosis: Calcification of annulus fibrosus. Death due to carcinoma of the rectum and peritonitis. Roentgenogram of the post-mortem specimen shows calcification of annulus fibrosus and of coronary arteries, also calcification in the ligamen-

tum arteriosum. No lime salt deposit in either the aorta or pulmonary artery. *Saul* (1932): Case 1. Woman aged eighty. Roentgen examination: In the anterior position just to the left of the spine, there is a sickle-like area of irregular calcareous deposits, the excursions of which are larger than the pulsatory excursions of the heart silhouette. Post mortem: Calcification of the annulus fibrosus. Case 2. Man, aged eighty-six. Roentgen examination: In the left half of the heart shadow there is a homogeneous shadow. Its concavity is caudad and mesad. Its pulsations are more vigorous than those of the heart borders. The movement is rotary clockwise and at the same time vertically downward. Case 3. Woman, aged seventy-seven, with systolic murmur at apex. Roentgen examination: Half-moon-shaped calcareous shadow near the posterior heart wall, pulsating. Best seen in slightly right anterior oblique and lateral positions. *Parade and Kuhlmann* (1933): Case 1. Man, aged seventy-two, with negative cardiological findings. Roentgen examination: Within the heart there is a half-moon-shaped shadow with the density of lime salt, with dancing movements. Post mortem: Calcification of posterior portion of the mitral ring. Case 2. Man, aged sixty-one, with negative cardiological findings. Roentgen examination: Within the heart shadow there is a small calcareous area, downward convex with dancing movements, during systole from right to left and downward. Case 3. Man, aged twenty-five. Clinically: Mitral stenosis. Roentgen examination: Within the heart shadow a small sickle-shaped calcified area, vigorously pulsating. Case 4. Man, aged twenty-two. Clinically: Aortic stenosis. Roentgen examination: In the region of the aortic valves there is a ring-like, not homogeneous shadow moving toward the apex during systole and best seen in a lateral view.

The roentgenologic diagnosis of calcareous deposits in the annuli fibrosi, valves and muscle of the heart is most readily made by roentgenoscopy. This is fortunate since the method is so widely applicable, whereas recording these shadows on films presents technical difficulties that can be overcome at present only by those who have at their disposal high-powered equipment. It is necessary to have the eyes fully adapted and to cone down the shutter to an area of a few square centimeters. In the anterior view, these calcareous deposits may be expected near the midline, sometimes a few centimeters to the left of it, about at middle height or within the lower third of the mass of the heart shadow. The projection of choice is obtained by rotation of slight degree into the right anterior oblique position, perhaps 15°, thus freeing these calcareous deposits from the dense unhomogeneous shadow of the spine. In the lateral view these deposits may be expected around the middle or within the posterior third of the mass of the heart. The characteristic diagnostic finding is the motion of these deposits. These movements are quite extensive, far greater than is noted at the peripheral borders of the heart and "dancing" (or "jerking") in character. The type of movement is complicated. It consists first of a movement downward and slightly forward; secondly, it has a rotary character; the result is an elliptical movement. Thirdly, the speed of the movement is not constant, but sudden step like changes in its speed are noted. In those cases where a band-like calcification is noted its length will vary considerably in different positions but in all positions these calcareous deposits appear within the shadow of the heart.

Ordinary chest (heart) films will rarely demonstrate this type of calcification for several reasons: (1) The ordinary technique is designed to demonstrate lung detail. For the purpose of demonstrating the calcareous deposits within the heart the film is thus underexposed and the quality of rays is not penetrating enough. (2) Many chest (heart) films are not taken in a sufficiently short time, especially if there is standardization to the 7-foot target film distance. In considering the rapid and rather extensive movement of these calcareous deposits, an exposure of 1/15 of a second is desirable, 1/30–1/40 of a second is ideal. (3) In a chest (heart) film including a large space like the 14″×17″ film, secondary radiation may interfere with contrast. Coning down the area is thus desirable, though it lengthens the exposure time. (4) The 1000 ma. technique is not ideal because of the necessary size of the focal spot which necessitates an increased distance in order to permit fine detail. (5) In the anterior position the calcareous deposits are located mostly in the midline or just to the

left of it. Thus they are in the same sagittal plane with the spine and they therefore project in this part of the heart shadow which is most dense and least homogeneous. The requirements of short exposure and finest details are best fulfilled by the Rotalix tube. The older model we have used permits 400 ma. and 65 kv. at the three-phase machine. This we found to be satisfactory only for the demonstration of calcareous deposits within the heart of the thin-walled, lean type of patients. A new model of this tube allows higher voltage and thus will serve for all types. Satisfactory roentgenograms have also been obtained with the 100 ma. technique, for instance by Parade and Kuhlmann—80 cm. target-film distance, 100 ma., 90 kv., 1/15 sec., and by us in a thin patient (Fig. 7) with 70 cm. target-film distance, 100 ma., 90 kv., 1/10 sec.

The position of a shadow of a calcareous nature inside of the heart shadow and the characteristic movements of these calcareous shadows do not leave many other diagnostic possibilities. Calcified thrombi represent rather large, round or oval masses. A roentgen observation of this sort with post-mortem report was published by Besser and Schilling. Calcification in the heart muscles following coronary disease, usually within an aneurysmal formation is noted near or at the apical portion. Roentgenological observations with post-mortem report are published by Scholz, Jaksch-Wartenhorst, and Determann. Neither calcification of the auricular or ventricular endocardium, nor muscular calcification other than just mentioned has been reported roentgenologically as far as we know. Pericardial calcification can be localized at the periphery of the heart. Calcareous deposits may extend from a calcified pericardium into the heart muscle, but fundamentally only the diagnosis of calcified pericardium could be made in these cases. There should be no difficulty in excluding calcified areas in the rib cartilage, calcification of the chest wall arteries, calcification within lymph nodes or bronchial walls since all of these shadows can be projected outside that of the heart shadow by rotating the patient. In studying post-mortem specimens by roentgen rays it is advisable to remove the largest part of the atria and ventricles and take a film from above (Giese).

PHYSIOLOGICAL ASPECT

The study of the movements of the calcified heart skeleton and the heart valves has an important physiological aspect. The excursions thus observed are greater than the amplitude of pulsations observed along any contour of the heart silhouette. Thus we obtain proof (one of the proofs) that for the mechanics of the heart contraction, and consequently for the output of blood, the pumplike action of the atrioventricular septum is of prime importance.

Other roentgenological observations along the same line may be cited here. In the literature reporting the study of bullets or pieces of them located within the heart, 4 cases are of special interest (Finckh, Franchini, v. Zezschwitz, Ohm). In these cases where fixation had taken place within the heart near the atrioventricular septum, marked excursions were observed, clearly indicating that during the ventricular systole the previously mentioned septum was moving toward the apex. The excursions amounted to 1 cm. in Finckh's case, 2–3 cm. in Ohm's and 3 cm. in v. Zezschwitz's case. Sundberg injected lipiodol into the pericardial cavity of rabbits; since the lipiodol gathers principally in the atrioventricular groove, it was possible to register by roentgen kymography the movements of this part; it amounted to $\frac{1}{3}$–$\frac{1}{4}$ of the total length of the heart. Hamilton and Rompf studied roentgenologically the movement of the base of the heart in animals by placing the barbed point of a fish hook or bits of silver wire in the ventricular wall near the atrioventricular groove. The movements of these foreign bodies were "fantastically vigorous" as compared with the small undulations of the edges of the ventricular shadow.

Meek, Meek and Eyster, and Hodges have tried to determine the "cardiac out-

put" derived from calculations which have as their basis the difference in area of the systolic and diastolic roentgen heart shadows. This method and therefore the conclusions drawn from it are subject to grave objection, because of the fact that the "volume changes" thus obtained do not include the ventricles only and because the marked excursion of the atrioventricular septum is ignored.

Further studies in a greater number of cases, especially in those where no cardiac enlargement of noticeable degree is present, will shed light on the normal location of the mitral and aortic valves in the living. In comparing the statements as given in textbooks on anatomy with the majority of the above cited roentgenological observations, it seems that these valves are farther to the right, i.e., nearer to the midline, in the living than one might expect from the anatomical statements.

SUMMARY

The frequency of post-mortem findings of calcification of the left-sided annulus fibrosus and the aortic and mitral valves is cited.

Attention is called to the few reports* of the roentgen observation of these calcifications in the living and the rarity of correct diagnosis of their location. Three such cases are reported, all of them confirmed by autopsy study. The characteristic features of appearance, location and motion of these shadows in roentgenoscopic study are described, together with points of differential diagnosis.

It is our belief that these calcifications are more frequent than is realized and that the roentgenologist can play the leading rôle in their recognition by routine roentgenoscopic observation of the heart in routine chest examinations.

Some physiologico-pathological aspects of this type of calcareous degeneration are described together with illustrative cases from the literature.

* Since the preparation of this paper Sosman and Wosika[47a] have added 39 cases, all diagnosed roentgenographically in vivo.

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PULMONARY TUBERCULOSIS IN CHILDHOOD

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THIS study is based on observation of a series of chest roentgenograms made over a period of years on tuberculin tested children. At Lymanhurst School for Tuberculous Children and its out-patient department we have had the opportunity to observe over 10,000 such children, all of whom have been roentgenographed at least once and many of whom have been observed and reëxamined roentgenologically over a period of ten years. A large number have also been seen under similar circumstances at Glen Lake Sanatorium and in its out-patient department. The original roentgen examination is made by stereoscopic films. Thereafter, unless otherwise specified by the roentgenologist, roentgen examinations consist of single films at intervals of three months. Many of these children are roentgenographed in one or two oblique positions, and other special methods of examination are employed. At both institutions the tuberculin reaction and the roentgen examination are considered the important factors in diagnosis. The first demonstrates tissue sensitivity to tuberculosis in those reacting positively to tuberculin. The second demonstrates visually the point at which sensitization took place as well as the size and clinical importance of the lesion. The physical examination is of very minor importance, because of the lack of signs in childhood tuberculosis.

It is possible to classify all types of pulmonary tuberculosis which we have seen occurring before adult life under four main divisions, of which all but the first are subdivided into smaller groups. However, for all practical purposes, clinical or otherwise, the subdivisions are of little importance. Grouping the different types of pulmonary tuberculosis occurring in childhood under four different headings should not only give a definite mental image of each child's present status but should also give a clear idea of what has previously occurred in the chest. In addition, it furnishes a definite basis for prognosis.

The classification of first infection tuberculosis in childhood is:

A. Known infection with no demonstrable lesion.

B. Uncalcified tuberculosis of the primary pulmonary or childhood type.

C. Calcified tuberculosis of the primary pulmonary or childhood type.

D. Adult type tuberculosis with or without demonstrable primary focus.

A. *Known Infection with no Demonstrable Lesion.* This group is by far the largest. In well over half of the cases we have seen in which the Mantoux reaction was positive, no chest lesions attributable to tuberculosis were demonstrated.

The failure to demonstrate a tuberculous lesion may be due to one of several factors. Perhaps such failure is due most often to the minute size of the lesion present. It has been shown that even in excised lungs about one-fourth of the proved calcification of primary tuberculous infection is not visualized by roentgen examination. Many lesions, either calcified or fibroid, are so small or of such a contour as to cast a shadow which cannot be identified on the film as being due to other than normal structures. This holds true of lesions not only in the lymph glands of the mediastinum and the hilus but also in the lung parenchyma. Another potent cause for failure to demonstrate a lesion exists in those cases in which the lesion is overshadowed by the bony structures, the shadows of the diaphragm, mediastinum or hilus. Rarely, also, a patient may be roentgenographed at a period during the course of his disease in which there are definite pathological changes present which do not cast abnormal shadows. In such cases, tuberculous enlargements of the hilus glands, and more rarely parenchymal infiltration, may have resolved to a point where they cast no

recognizable shadows but are destined to proceed later to calcification, fibrosis, or both.

Though we are dealing with pulmonary tuberculosis only in this discussion, it is important to bear in mind that not all primary tuberculous infections are pulmonary in type. In a recent study we found in a series of children who reacted positively to the Mantoux test but who had no roentgen evidence of pulmonary tuberculosis that approximately 2 per cent showed calcified mesenteric glands on roentgen examination. It is very reasonable to assume that these and these only represented their tuberculous infections. The original infection may be in any of a number of locations, though usually it is in the chest.

B. *Uncalcified Tuberculosis of the Primary Pulmonary or Childhood Type.* Interpretation of this highly important group must be based upon a knowledge of the underlying pathological changes. The primary focus is situated in any part of either lung and takes the form of tubercle formation. Occasionally, it may be bilateral. Its size varies within wide limits. However, it has been our experience that its size, within reasonable limits, is of little more than academic interest because of the good prognosis it offers. An area of collateral infiltration immediately develops around the primary pulmonary focus. This infiltration often obscures the primary focus and does not permit an accurate concept of its size. This collateral infiltration is pneumonic in type and varies in extent from a small area to consolidation of an entire lobe or more. The primary focus soon progresses to caseation and becomes encapsulated with fibrous tissue. Healing occurs by contraction and calcification, or, more rarely, by fibrosis of the primary focus, and resorption of the collateral infiltration. Hand in hand with these changes there occurs a similar involvement of the regional lymph nodes as a result of their invasion by tubercle bacilli draining, in a retrograde fashion, from the primary focus. The course of the entire process from onset to relative inactivity requires months and often extends over a period of years. The term "relative inactivity" is used advisedly as it has been shown that complete inactivity may never occur. Pathologists describe recent tubercle formation about primary foci which appear to have been densely calcified for a period of years.

In unfavorable cases the primary focus may break down with cavity formation. Various complications caused by dissemi-

Fig. 1. Case 1. August 28, 1930. L. L., aged one year. Primary pulmonary tuberculosis involving the base of the right upper lobe. Note the paratracheal gland enlargement.

Fig. 2. Case 1. May 21, 1931. The lesion has resolved slightly at the periphery.

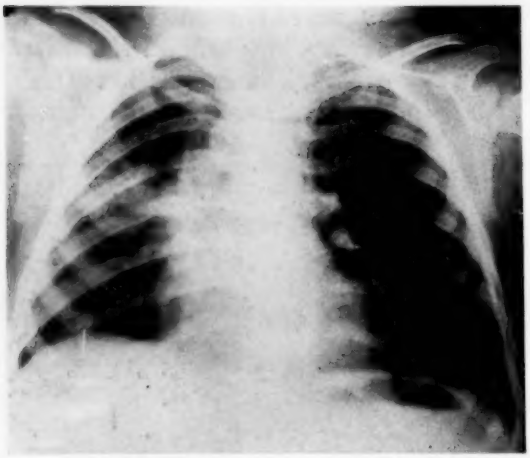

FIG. 3. Case I. July 31, 1931. Further resolution has occurred and flecks of calcium are appearing in the parenchymal lesion and in the adjacent lymph nodes.

nation of the tubercle bacilli may occur. This, we believe, happens in those cases in which the primary infection is massive. We have observed such complications as manifested by cavitation, miliary tuberculosis, bone tuberculosis, and tuberculous enteritis which developed during the evolution of an uncalcified pulmonary lesion of the first infection type. These complications, however, are extremely rare.

The roentgen appearance of resolving parenchymal lesions is by no means constant but after observing a number one can usually recognize them at the first examination. Typically, they appear as homogeneous, dense opacities involving a lobe or roughly triangular portion of a lobe with the base of the triangle towards the periphery. At the onset of the disease the extent and density of this shadow is greatest. Quite frequently, the hilar and mediastinal lymph nodes draining this area can be visualized as a separate lobulated mass. As resolution occurs the peripheral portion of the parenchymal density clears first and the resolution extends inward towards the hilus. When resolution has become partially established the density and homogeneity of the remaining more central portions of the lesion decrease. At about the same time calcification becomes visible in flecks throughout the primary focus. The density of the infiltration further decreases and finally completely disappears at about the time the calcified deposits fuse into one or more dense Ghon tubercles. The involved lymph nodes gradually decrease in size, become denser and develop calcium deposits as the regression of the parenchymal lesion occurs. Pleural thickening over the involved area is usually present and when such involvement takes place along an interlobar septum this becomes thickened. Hydrothorax occasionally oc-

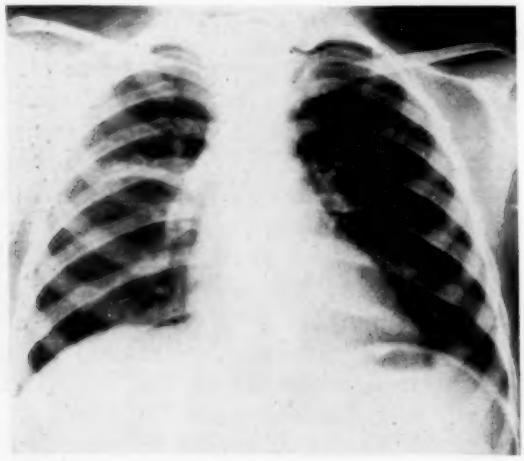

FIG. 4. Case I. September 1, 1932. Resolution and calcification have progressed.

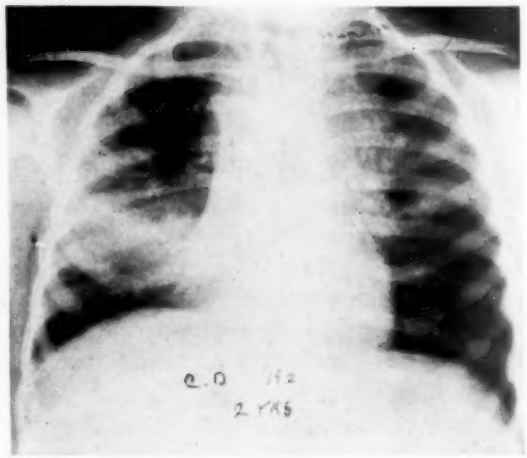

FIG. 5. Case II. March 27, 1923. C. D., aged two. Bi-lateral childhood tuberculosis.

curs. Pleurodiaphragmatic adhesions rarely develop.

The above description is typical, but it must be remembered that variations are frequent. Also, the same lesion presents widely differing appearances in its evolution and roentgenograms may be taken at a time when differentiation is by no means simple.

The most frequent lesion simulating such a resolving parenchymal tuberculosis is pneumonia. If at the time of the original examination enlarged glands at the hilus are present, the condition is more than likely tuberculosis. If the roentgenologist

Fig. 6. Case II. January 2, 1924. Partial resolution has taken place in the left upper and right middle lobes. The right upper lobe is now completely consolidated.

cannot be sure of the differential diagnosis at the original examination he may take another roentgenogram in a week or ten days. If the lesion is unchanged the diagnosis is obvious. It is very important from a clinical standpoint to differentiate adult and childhood types. This is done by: (1) the well-known appearance of the adult type infection usually in the upper half of the lungs; (2) previously existing calcification which is evidence of a previous primary infection; (3) the presence of enlarged hilus glands in childhood type and their absence in adult type, and (4) if necessary prolonged observation, a period of

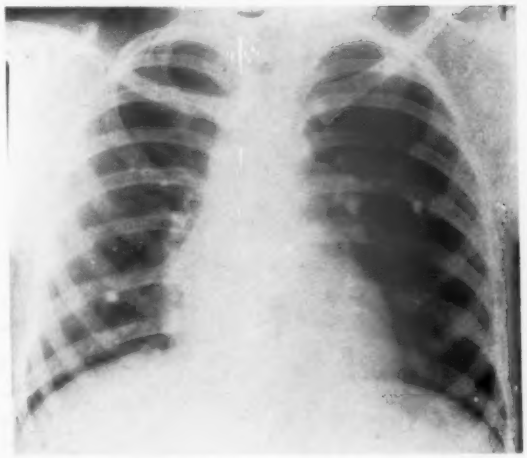

Fig. 7. Case II. August 9, 1932. Present appearance of the chest which has not changed appreciably since October 20, 1925.

which eventually shows that childhood tuberculosis has a tendency to improve and calcify while adult type tuberculosis tends to increase without calcification. Bronchiectasis may be confused with childhood tuberculosis, but in bronchiectasis the lesion is usually bilateral, and on long observation remains stationary or increases. Occasionally differentiation from pulmonary abscess is necessary. Clinically, with a knowledge of the history, the physical findings, tuberculin reaction and roentgen

Fig. 8. Case III. February 4, 1929. J. A., aged eight. Childhood tuberculosis is shown by the enlarged nodes at the root of the right lung. A primary focus is not demonstrable.

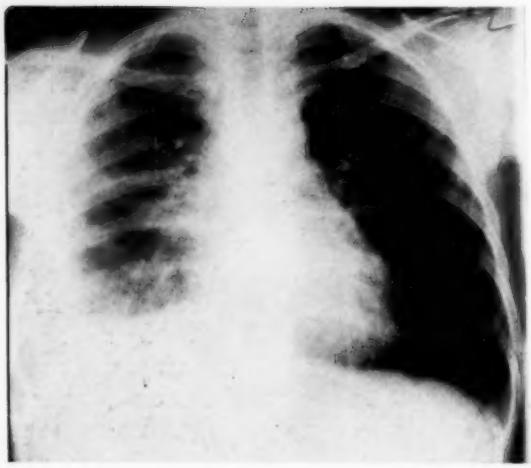

FIG. 9. Case III. November 6, 1929. The hilus nodes remain enlarged. A pleural effusion has developed.

appearance, the diagnosis is usually easy.

Primary tuberculous involvement of the tracheobronchial lymph nodes may occur without a demonstrable pulmonary focus. The diagnosis in these cases depends on actual visualization of a rounded density or lobulated mass extending into the lung parenchyma from the hilus or mediastinum or both. Because of the great variations seen in normal hila we do not make the diagnosis of tuberculosis unless there is definite evidence of enlarged nodes, slightly more dense to roentgen rays than normal lung structure, outside the hilus area. This type cannot well be diagnosed from a roentgen standpoint if the lymph node enlargement is small or if it extends inwardly rather than peripherally. For our caution we are occasionally embarrassed by seeing calcium deposited at a later date in structures which we had called normal. However, the usual tendency is to err in the opposite direction and we feel that it is better to miss an occasional case than to diagnose hilus tuberculosis in many suspected children with questionably enlarged hilus structures. Also, there are several other causes for enlarged tracheobronchial nodes which must not be overlooked in classifying such cases. Regression in this type occurs as in the foregoing group, namely, by resolution and calcification or fibrosis.

The uncalcified parenchymal and hilus gland tuberculosis is encountered in only a small percentage of children's chests. Even in average tuberculin positive groups, composed of children ranging from infancy to seventeen or eighteen years, it will not be seen in more than 4 or 5 per cent of all cases.

C. *Calcified Tuberculosis of the Primary Pulmonary or Childhood Type.* This group is composed of those children who have undergone the changes outlined in the previous paragraphs with resolution and development of a stable lesion. About 25 per cent of the children with a positive Mantoux reaction fall in this group. This is the most important group, numerically, as most of the cases with positive chest findings fall under this classification. The discovery of calcified deposits gives definite evidence of the tuberculous nature of the lesion except in rare instances. These rare exceptions include the cases in which the tuberculous infections have completely burned themselves out or in which the calcification is due to some other infection.

The lesions in this group may assume numerous forms, the outstanding feature of which is calcification. They may be grouped in three divisions, the first of which, calcification in the hilus or paratracheal nodes,

FIG. 10. Case III. March 9, 1932. Calcification has occurred in a node at the root of the lung. The chest is otherwise normal in appearance.

is most frequently encountered. These make themselves evident on the film as dense irregular deposits in the nodes at the lung roots or along the trachea. They vary in size from minute flecks to masses a centimeter or more in diameter. The recognition of large calcium deposits is easy, that of small deposits is often difficult. Usually they can be demonstrated on ordinary chest exposures but often they can be seen only on films made in the oblique positions. This is particularly true of those lesions lying within the bifurcation of the trachea and those lying directly adjacent to the trachea or main bronchi. The denser structures quite often obscure calcifications in these areas in plates made in the ordinary position. When the site of the primary focus is in the lower lobes it is not uncommon to see large numbers of calcified glands lying along the ramifications of the descending bronchi.

Blood vessels must be differentiated from calcifications at the hilus. They present, when viewed axially, rounded homogeneous densities which disappear on oblique films in contrast with the irregular heterogeneous densities of calcium which remain constant on the oblique films. The movement of the heart and the blood vessels often obscures calcification by blurring but in a series of films on an individual even the smaller deposits will be recognizable in one or more of the films, particularly those made in diastole. Necessarily, a certain amount of calcification of minute size will escape detection.

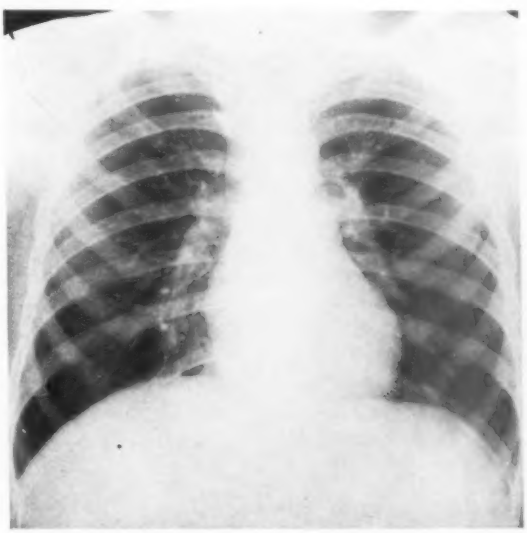

Fig. 11. Case iv. December 6, 1932. R. L., aged twelve. No pulmonary tuberculosis demonstrable.

Fig. 12. Case iv. December 6, 1932. Calcified childhood tuberculosis is evidenced by a gland at the bifurcation of the trachea and a Ghon tubercle in the right base.

The second division under calcified childhood tuberculosis constitutes those cases showing calcified hilus or paratracheal nodes with single or multiple Ghon tubercles in the parenchyma. A surrounding area of fibrosis may or may not accompany the Ghon tubercles. In this group, the recognition of calcification in the parenchyma is made by the same criteria and is made difficult by the same factors as apply in diagnosing calcification at the hilus. However, the size of the deposits of the calcium being equal, calcification in the parenchyma may be identified more accurately than in the hilus. Ghon tubercles occur in the parenchyma of the lung fields and appear as calcified densities, varying in size from that of a pinhead to large areas sometimes more than a centimeter in diameter. They are not usually round and their edges are serrated, and except in the stage of

transition from an uncalcified lesion they tend to be calcified uniformly. Viewed stereoscopically, they give the appearance of minute fragments of coral. Blood vessels are differentiated from calcified primary foci by their smooth round edges, by their situation along dimly visualized vessel trunks, and by their disappearance on rotation of the patient. Those cases in which the healing of the primary focus has taken place predominantly by fibrosis are infrequent and the fibrosis, if at all extensive, is easily recognized. It varies in appearance from the fibrosis of adult type tuberculosis in that it is usually of finer strand-like structure, is connected with the hilus, and is usually associated with calcification there. The fibrotic area tends toward a triangular shape with the base connected with the hilus and the apex toward the periphery.

The third group under calcified childhood tuberculosis is that group in which only a calcified primary focus is present. Such cases are rare. The attempt at healing here has evidently occurred by calcification in the primary focus but with such minute calcium deposits at the hilus that they cannot be identified. Or perhaps the nodes at the hilus and along the mediastinum remain caseous and encapsulated by fibrous tissue for many years. A third possibility is that healing occurs in these nodes but is represented only by fibrous tissue which would not cast a shadow different from normal hilus structures. However, visualization of a Ghon tubercle gives diagnostic evidence of calcified childhood tuberculosis even though the changes in the nodes at the lung roots are not visible.

D. *Adult Type Tuberculosis*. Adult type tuberculosis occurs upon reinfection of those children who have previously been sensitized by a childhood type infection. On the whole, reinfection in childhood is no different than when it occurs in adult life except that apparently its prognosis is even more grave. It is therefore highly important to recognize the reinfection as such.

The development of the adult type of pulmonary tuberculosis occurs in a high percentage of cases in the presence of a demonstrable childhood tuberculosis of the calcified type. At least 50 per cent of all children with adult type tuberculosis have it superimposed on a demonstrable childhood tuberculosis.

There is one type of adult tuberculosis occurring in childhood which is worthy of special mention. This manifests itself as single or multiple, well-circumscribed, circular or irregular areas of density in the apices occurring from the eighth to the tenth year onward. These areas of infiltration represent reinfection and are characterized by their stability, their only change being an extremely slow gradual increase in size. Sometimes cavitation is present. The lesion is usually associated with calcified childhood tuberculosis but not necessarily in proximity to, or even in the same lung as the calcified childhood tuberculosis. At adolescence or slightly thereafter these lesions tend to flare up and break down, developing into a rapidly destructive type of pulmonary tuberculosis. This type represents, in our minds, a true latent tuberculosis. The patient is usually symptom-free and therefore unwilling to attach importance to the lesion. In reporting such a lesion, we mention its gravity and its probable course.

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DEFORMATION OF THE SELLA TURCICA IN TUMORS OF THE MIDDLE CRANIAL FOSSA

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IN THE search for evidence of intracranial disease the attention of the roentgenologist is, in a large measure, centered upon the sella turcica. The reason for this is the fact that, of the various roentgen manifestations of disease of the cranial contents, alterations in the structure of the sella turcica occur more frequently than do any other changes. This is particularly true in the case of neoplasms. A study of the sella turcica is indicated in every suspected lesion of this kind, as our records show that sellar deformities were found in approximately 61 per cent of cases of verified brain tumor.[1] As the result of a more critical analysis of the available material, which is being made at the present time, there is every reason to believe that this percentage will be materially increased.

The greatest value of the roentgen study of the sella turcica in the light of present knowledge is the evidence it offers for or against the presence of an intracranial neoplasm. Important as this information is, it is even more so that the alterations of this structure may be sufficiently characteristic to indicate the location of the lesion. Much has already been accomplished in this respect,[2] and it is on the basis of the present status of our knowledge that the following classification has been devised:

1. Intrasellar lesions
2. Extrasellar lesions
   (*a*) Suprasellar
   (*b*) Parasellar
   (*c*) Metasellar
3. Lesions of the sphenoid bone.

The deformity of an intrasellar lesion, by far the most characteristic and the first to be recognized, was described by Oppenheim[3] in 1899. Here the uniform enlargement of the pituitary fossa, the elongation and erect position of the dorsum sellae, the retention of the posterior clinoid processes, and the apparent elongation and erosion of the under surface of the anterior clinoid processes produce a picture that in a certain percentage of cases may be considered pathognomonic for a pituitary tumor (Fig. 1, *B*). No other lesion is possessed of this distinction.

Suprasellar growths are more infrequent and the type of deformity produced in the sella turcica less characteristic and less constant. In contradistinction to the intrasellar lesions, the posterior clinoid processes are usually the first structures to be destroyed. Likewise, the top of the dorsum sellae is usually absent. The pressure of a suprasellar lesion being directed first in the region of the diaphragma sellae, it is usually found that this portion of the pituitary fossa is definitely increased in its anteroposterior diameter. Many other changes in the appearance of the sella may occur, none of which, however, are at all constant. Fortunately, a large percentage of suprasellar tumors are calcified, and it is upon this finding that chief reliance in an accurate identification of the lesion can be placed (Fig. 1, *C*).

A parasellar lesion is one located directly on either side of the sella turcica in more or less immediate contact with this structure. These lesions are, of course, in the middle cranial fossa and will be dealt with in more detail subsequently.

All other intracranial lesions, except those described above, are included in the group designated as metasellar. A metasellar tumor, therefore, is one located beyond or at a distance from the sella turcica. This group includes most of the tumors of both the cerebrum and the cerebellum and comprises a large and heterogeneous class of neoplasms. While many of these lesions produce changes in the sella turcica, the only ones which have heretofore been

recognized as producing a characteristic alteration are those occurring in the posterior fossa—the infratentorial tumors. Particularly is this true of those involving the midline, which tend to obstruct the ventricular system. In this manner is produced a dilatation of the third ventricle which enlarges downwards, encroaching upon the sella turcica. This may result in an extensive destruction of the sella, causing a marked enlargement of the pituitary fossa and an encroachment upon the sphenoid sinus. The most characteristic feature of this type of deformity, however, is the appearance of the dorsum sellae. The posterior clinoid processes are first eroded, following which there is a gradual disappearance of the dorsum sellae from above downwards until eventually there is a complete absence of this structure (Fig. 1, *D*).

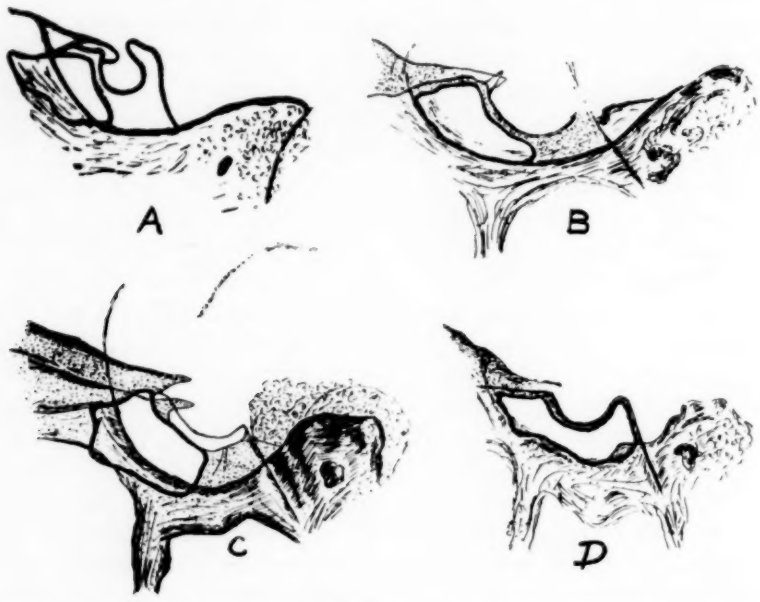

FIG. 1. Normal and abnormal sella turcica. *A*. Normal sella as seen in lateral roentgenogram of head. *B*. Characteristic deformity of intrasellar tumor. *C*. Suprasellar tumor. Note calcification of tumor above sella. *D*. Metasellar deformity produced by tumor in posterior cranial fossa.

It is recognized that the above classification is not entirely adequate, because the metasellar group comprises lesions which are too widely divergent in their nature and location. It was with the hope of further dividing this heterogeneous group that the present study was undertaken. During the past few years clinical observation has impressed upon us the frequency with which temporal lobe tumors produce changes in the appearance of the sella turcica. It was for this reason that the metasellar lesions occupying the middle cranial fossa were selected as a group in order to determine the frequency and character of the changes to be found in the sella turcica.

Of the large series of middle fossa tumors in the collection of the Neurosurgical Service of Dr. Charles H. Frazier, University of Pennsylvania Hospital, 40 were selected as fulfilling the requirements of this study. Chief among the requirements were a satisfactory roentgenogram of the pituitary fossa and a fair degree of accuracy as to the location of the tumor. This latter requirement is ideally fulfilled by a post-mortem study of the entire brain, but unfortunately the material did not afford a great number of cases of this kind. Operative localization had to be relied upon in most instances. Care was exercised, however, in selecting cases in which the tumor

was definitely in the middle fossa, and in those few instances in which other areas were also involved it was determined that the major portion of the tumor occupied the middle fossa. In fulfillment of this requirement practically all the lesions were either gliomas of the temporal lobe or fibroblastomas (meningiomas) of the middle fossa. One case was a sarcoma which, incidentally, crossed the midline and became bilateral. There was one case of gumma of the temporal lobe, and in this instance there was every reason to believe that the lesion was multiple. Also, in the cases of spongioblastoma multiforme the possibility of multiple lesions had to be considered, since multiplicity occurs in about one-third of these cases. However, in these instances it was evident from the data at hand that the major lesion was in the temporal lobe.

Of the 40 cases studied, the roentgenogram revealed deformation of the sella turcica in 34, or 85 per cent. In 2 of the 34, the changes were quite characteristic of a posterior fossa tumor. Since the middle fossa also contains the true parasellar lesions, it was possible in 14, or 35 per cent, of the remaining 32 cases to recognize the characteristic changes of a parasellar tumor. The remaining 18 (45 per cent) presented sellar changes, indicating their classification in that nondescript group of metasellar lesions. In only 6, or 15 per cent, were there no changes to be found in the sella turcica (Table 1).

In this connection it should be mentioned that a parasellar deformity does not necessarily mean that the tumor is primarily parasellar in origin. As a matter of fact, such lesions are relatively uncommon. Most parasellar deformities are produced by so-called parasellar extensions of lesions primary elsewhere. Temporal lobe tumors and fibroblastomas of the middle fossa would naturally give rise to the largest number of such extensions, and this fact is no doubt responsible for the high percentage (35 per cent) of parasellar deformities in this series. Frontal lobe tumors are probably next in frequency, while parietal and occipital lobe lesions less commonly give rise to parasellar extensions. Primary pituitary tumors not infrequently show a parasellar extension (Fig. 2). In a series of primary intrasellar tumors recently studied there was in 15 per

TABLE I

APPEARANCE OF THE SELLA TURCICA IN 40 VERIFIED CASES OF MIDDLE FOSSA TUMORS

	Cases	Percentage
Normal sella	6	15
Deformed sella	34	85
Parasellar deformity	14	35
Metasellar deformity	20	50
Posterior fossa deformity	2	5
Middle fossa deformity	18	45

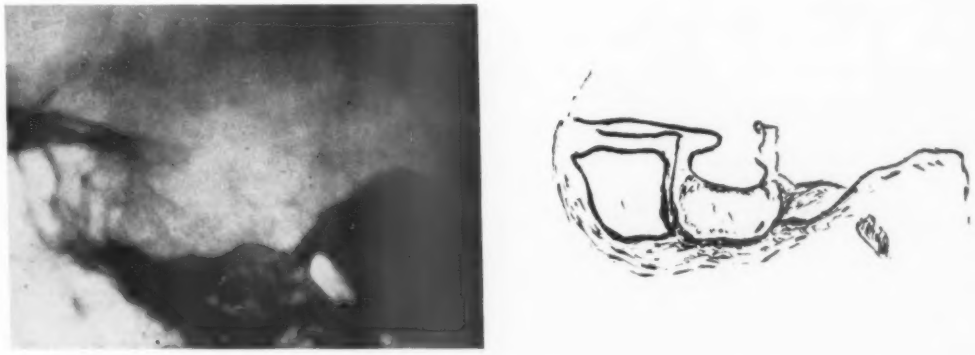

FIG. 2. Right parasellar extension of primary pituitary tumor. Roentgen diagnosis based on marked destructive changes in sella, consisting chiefly of unilateral erosion of pituitary fossa and erosion of one anterior clinoid process and finding of a left homonymous hemianopsia. Confirmed at operation.

cent of the cases evidence in the roentgenogram of such an extension of the growth.

In many of the cases of this series of middle fossa tumors the deformity found in the sella turcica was slight in degree and might have been readily overlooked unless cognizance were taken of all minor alterations. In reviewing the original interpretations of the 34 cases showing sellar deformations, it was found that the sella in 18 of these was readily be obscured or simulated by poor roentgenologic technique. It is of the utmost importance that there be obtained at least one clear view of the pituitary fossa. Lateral exposures of both sides of the head and preferably stereoscopic films are desirable, made, of course, with the Potter-Bucky diaphragm.

The alteration of the sella turcica found in this series of cases had to do primarily

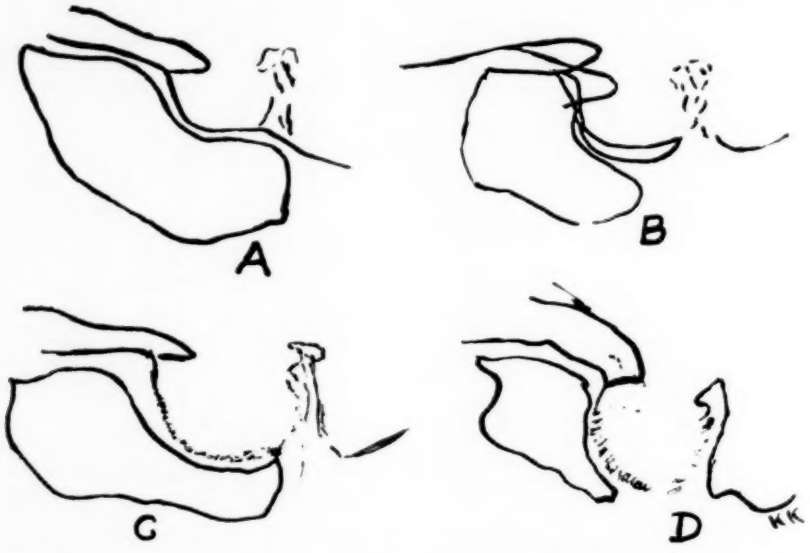

FIG. 3. Type of deformations of sella turcica found in tumors of middle cranial fossa. *A*. The only alteration is erosion of dorsum sellae. *B*. Erosion of dorsum sellae, top normal size of pituitary fossa. *C*. Erosion of dorsum and floor of pituitary fossa, with increase in size of fossa. *D*. Erosion of dorsum and floor of pituitary fossa. Size of fossa increased chiefly in depth. Posterior clinoid processes intact in all four cases.

originally reported as negative. It is interesting to note, however, that of these 18 some unusual feature was recorded in 11. These changes were not considered sufficient at the time to warrant an interpretation of an abnormal sella turcica. Top normal measurements of the pituitary fossa, that is, measurements from 8 to 10 mm. in depth and 10 to 12 mm. in the anteroposterior diameter were found in 8 instances. It is evident from these observations that minor changes in the sella turcica formerly regarded as of no significance cannot be too lightly dismissed in suspected cases of brain tumor. It must be mentioned, however, that such changes can with the dorsum sellae (Fig. 3). There was evidence of erosion manifested by a faintness, or indistinctness, in outline. Instead of the homogeneous appearance presented by the normal dorsum, this structure was frequently represented by multiple vertical lines. The posterior clinoid processes were usually intact but were somewhat indistinct. The pituitary fossa itself usually showed some enlargement, but this was frequently only slight in degree. Often the actual measurements were only top normal, but one could be sure from the indefinite outline of the fossa that some bone erosion had taken place. The increase in anteroposterior diameter was often the re-

sult of erosion of the anterior surface of the dorsum sellae. In some cases one measurement only was altered, but in most there was some increase in both the depth and the anteroposterior diameters.

The tuberculum sellae and the anterior clinoid processes were seldom deformed unless the tumor occupied a true parasellar position. Under such circumstances the changes in the sella were usually quite evident (Fig. 4). Direct pressure of the tumor caused an erosion of the dorsum which could be seen chiefly at its base. In one instance at least, there was complete unilateral erosion of the dorsum. At times the floor of the pituitary fossa was eroded on one side only, so that the appearance of a double floor was presented. In some instances the anterior clinoid process on the side of the lesion showed definite alteration, consisting either in a change in shape, a displacement upwards, or a complete absence. Frequently the tuberculum sellae presented, only to a less degree, the pointed appearance so commonly seen in intrasellar tumors. Thus, in the parasellar lesions there was found evidence of a unilateral erosion of the sella turcica (Figs. 5 and 6).

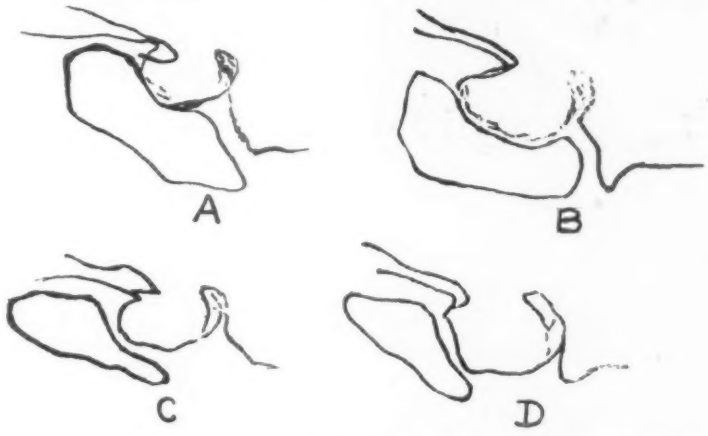

Fig. 4. Some deformations of sella turcica found in parasellar tumors, changes consisting chiefly in erosion of dorsum sellae, especially at base, retention of posterior clinoid processes, erosion of floor and one side of pituitary fossa, with increase in its size, and pointed appearance of tuberculum sellae.

Although the sellar deformity may indicate a middle fossa tumor, it is sometimes difficult roentgenologically to determine the side of the head in which the lesion is located. Stereoscopic films are usually of help in this respect, but in view of the close proximity of the two sides of the sella, it may be difficult even with stereoscopic films to definitely lateralize the lesion. Other means of accomplishing this may be employed. Thus, films made in a slightly oblique position from a true lateral will prevent superimposition of the anterior clinoid processes and may reveal a deformity of one or the other. A satisfactory view of the individual anterior clinoid processes may also be obtained by a posteroanterior projection, employing the position used for examining the maxillary sinuses but increasing slightly the angulation of the tube towards the top of the head. At times it is possible by means of the anteroposterior exposure, used for obtaining a view of the occipital bone and posterior fossae, to project the dorsum sellae so that it appears within the foramen magnum. This permits an examination of both sides of the dorsum and will show a unilateral destruction which is difficult to recognize in lateral films of the head.[4]

It is common knowledge that a sellar deformity suggestive of a tumor in a given locality is not infrequently found in lesions located in other parts of the cranial cavity. Likewise, the changes described above and found associated with tumors in the middle

cranial fossa may be produced also by lesions elsewhere. A rather cursory and incomplete survey of tumors in other localities would indicate that a similar deformity occurs in about 20 per cent of cases. Thus, while the changes described are indicative of a metasellar lesion, the probability of the tumor being in the middle fossa would appear to be more than twice as great as for any other locality. We believe, therefore, that this type of alteration of the sella turcica has a distinct localizing value.

No doubt the fact that tumors in locations other than the middle fossa may produce changes identical to those described is due in many cases to invasion of the middle fossa by lesions primary elsewhere. Another factor to be considered is the possibility that tumors may be multiple, and thus the middle fossa may be involved in a patient whose symptoms and clinical studies indicate a lesion in some other portion of the cranial cavity.

Fig. 5. Typical deformation of sella turcica in parasellar tumor. (See Fig. 6.)

Table II

Frequency of various roentgen manifestations of intracranial neoplasms*

	Cases	Percentage
Deformation of the sella turcica	34	85
Other roentgen manifestations of tumor	12	30
Calcification of tumor	9	22.5
Convolutional atrophy	4	10
Pineal shift	1	2.5

* Based on 40 verified cases of middle fossa tumors.

In the study of roentgenograms of the head one soon becomes impressed with the fact that sellar deformities cannot be solely relied upon for the localization of brain tumors. Fortunately other roentgen signs are frequently present which aid materially in the detection and localization of such lesions. In this series of middle fossa tumors, however, such manifestations were not common, only 12, or 30 per cent, presenting other roentgenologic signs of tumor (Table II). This is in marked contrast to the 85 per cent of sellar deformations. Thus, in 55 per cent of the cases, alteration of the sella turcica was the only roentgen manifestation of brain tumor. Of the 12 cases showing other evidences of an intracranial lesion, 9, or 22.5 per cent, presented the most reliable of all signs of brain tumor, namely, calcification. In all but 2, the calcification was sufficiently characteristic to leave no doubt as to the presence of a tumor. In 4 instances there was convolutional atrophy, with widening of the sutures, all in patients less than twenty years of age. In 2 of these there was also calcification. In one case there was a definite lateral displacement of a calcified pineal body. Mayer[5] has described various roentgen signs found associated with parasellar tumors.

As in most forms of roentgenologic interpretation, a knowledge of the symptoms and the results of other laboratory studies

is essential to the proper evaluation of the deformations found in the sella turcica. In the symptomatology of middle fossa tumors are to be found many symptoms common to neoplasms in other localities. Again, the fact that lesions are frequently not strictly confined to the middle fossa or may be multiple, complicates the clinical picture. Probably the most helpful single finding in middle fossa lesions is a homonymous hemianopsia. In the present series, this was found in 67.5 per cent of cases, absent in 12.5 per cent, and not recorded in 12.5 per cent, while in 7.5 per cent there was complete loss of vision in the eye of the involved side. It should be remembered, however, that homonymous hemianopsia is a frequent finding in occipital lobe lesions. It also occurs in a small percentage of primary pituitary tumors (Fig. 2), instead of the customary bitemporal hemianopsia. Such a finding accompanying the characteristic deformity of an intrasellar lesion indicates a parasellar extension of a pituitary tumor and is helpful in determining the side on which the tumor should be approached surgically.

The presence of uncinate attacks manifested by the smelling of disagreeable odors, accompanied by unpleasant tastes, with or without smacking of the lips, chewing or swallowing, and terminating in the so-called "dreamy state," is highly significant of a lesion involving the uncus which occupies the inferior and medial portion of the temporal lobe. Such attacks, however, are not frequently encountered. In this series they were recorded in 12.5 per cent of cases. Tumors involving the uncinate portion of the temporal lobe are truly parasellar in location, as the uncus lies just alongside the sella turcica. With a history of uncinate fits, therefore, one should examine the sella carefully for parasellar changes.

Motor weakness is another symptom commonly encountered in middle fossa tumors. It was present in varying degrees in 57.5 per cent of cases. Other symptoms quite as significant, but less frequent, are pain in the face in the distribution of the trigeminal nerve from involvement of the gasserian ganglion, ptosis of the upper eyelid, and disturbances in ocular rotations from involvement of the oculomotor, abducens, and trochlear nerves; also unilateral exophthalmos from pressure upon the cavernous sinus or direct involvement of the orbit. When found accompanying any of the above symptoms, the sellar deformity which has been described is additional evidence that the suspected lesion is probably in the middle cranial fossa.

While 85 per cent of the cases of this series showed deformation of the sella turcica, it must be remembered that this result was obtained with the full knowledge of the existence of a tumor and also of its approximate location. It is not expected that such a high percentage will be approached under ordinary clinical conditions. However, our own experience indicates that more accuracy can be attained

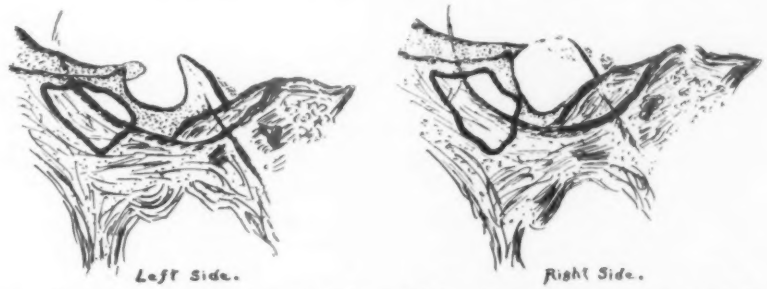

Fig. 6. Same case as shown in Figure 5, showing left and right sides of sella turcica. On left side there will be seen slight enlargement of pituitary fossa and pointed appearance of tuberculum sellae. Dura behind dorsum sellae is calcified. Right side shows marked erosion of floor of pituitary fossa, right anterior clinoid process deformed, dorsum sellae invisible, and some abnormal calcification present. Meningioma adjacent to sellae on right side was found at operation.

both in determining the presence of a tumor and in localizing such a lesion when greater care is exercised in the examination of the sella turcica. This study has already been of material aid to us, as some of the later cases of this series will testify.

CONCLUSIONS

1. In a series of 40 verified cases of tumor occurring in the middle cranial fossa, 34, or 85 per cent, showed deformation of the sella turcica as seen in the roentgenogram.

2. The type of deformity found in these cases is described.

3. This sellar deformation when correlated with the clinical manifestations of the case should materially increase the accuracy of the roentgen localization of tumors of the middle cranial fossa.

The author desires to acknowledge his indebtedness to Dr. Charles H. Frazier and the Department of Neurosurgery for making available the clinical material used in the preparation of this paper.

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Vol. XXXI, No. 1

DEMONSTRATION OF A SPONTANEOUS INTERNAL BILIARY FISTULA BY ROENTGEN EXAMINATION*

REPORT OF A CASE

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DURING the course of roentgenoscopic examination of the stomach of a patient from the Out-Patient Department of the Lakeside Hospital, it was observed that the bile ducts filled with barium. The novelty of this phenomenon prompted a survey of the literature. It was found that numerous cases of this kind had been reported and that in most instances a diagnosis of a fistulous tract between the duodenum and the gallbladder had been made. These reported cases usually presented a fairly typical history of biliary or duodenal disease, whereas our patient's history did not suggest any known disease entity. Inasmuch as the roentgen visualization of the biliary tree is unusual, and as a negative history of biliary or duodenal disease in this condition is uncommon, we present a case report on our patient. In addition, we have included the results of the roentgen studies on another patient who had a cholecystenterostomy. A tabulated review of the literature is appended.

CASE REPORTS

CASE 1. A white male, aged fifty-one, came to the medical Out-Patient Department of the Lakeside Hospital on February 17, 1932, complaining of occasional vomiting and loss of appetite for the past one and one-half years.

The family history and the past history were negative.

About one and one-half years before admission the patient first began to have attacks of nausea and anorexia. He had no pain in the abdomen but sometimes felt a dull heavy sensation in the epigastrium. He believed that the eating of cabbage, apples, or oranges brought on these attacks. The first attack lasted about two weeks following which he was in good health for six months. He then had a second attack of about the same duration, and following this he was well until three weeks prior to admission when the same symptoms recurred. The only additional symptom was occasional regurgitation of food. Bowel movements had been irregular for several years, necessitating the use of cathartics. He had never had typhoid fever. He had

FIG. 1. Case 1. Barium filling of biliary ducts. HD—hepatic duct. GB—gallbladder. CD—common duct. F—fistula.

no belching, jaundice, or bloody, tarry or clay-colored stools, and denied any pain in the abdomen. He had lost 6 or 7 pounds in the three or four weeks prior to admission.

The physical examination was negative. The skin and sclerae were not icteric. The pulse rate was 42 per minute. Electrocardiogram showed the mechanism to be a sinus bradycardia with ventricular escape beats. The sigmoid colon was rope-like. There was no clubbing of the fingers or toes.

On February 24, 1932, a roentgen examination of the stomach was made. The stomach was high in position, with good tone and active peristalsis. With the patient standing, the duodenal cap seemed small and flattened, but there was no delay in the passage of the barium into the second and third portions of the duodenum and into the jejunum. With the patient prone, however, and following a deep wave of peristalsis, the bile passages were visualized. The main

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ducts emptied rapidly and were seen to fill again after another wave of peristalsis (Fig. 1). The portal of entry of the barium into the biliary passages was not at once determined, but apparently it was in association with the first portion of the duodenum, rather than the ampulla of Vater.

Cholecystograms, after oral administration of the dye, did not visualize the gallbladder.

Two days later the patient came into the hospital for twenty-four hours, at our suggestion, so that further studies could be made. Intravenous cholecystography confirmed the results of the oral administration. A gastric analysis was then done and upon its completion the Rehfuss tube was inserted into the duodenum and a specimen of duodenal contents withdrawn. The position of the tube in the duodenum was confirmed by roentgenoscopy.

FIG. 2. Case I. GB—gallbladder. F—fistula. C—duodenal cap. P—pylorus.

Barium was then injected through the tube and its course through the duodenum carefully observed. There was no delay, no abnormality of outline, and the biliary passages were not visualized. The tube was then withdrawn and the patient was given barium by mouth. The stomach and duodenum appeared normal in every respect. With the patient standing, barium did not pass into the biliary ducts, despite vigorous palpation and pressure. With the patient prone, however, after a vigorous wave of peristalsis, the liver tree was again visualized as upon the first examination. At this time the biliary communication was seen to be definitely in association with the duodenal cap (Fig. 2). After four hours, there was a slight gastric retention and only a few of the finer rami of the right hepatic duct were visible.

The results of the gastric analysis were as follows:

	Vol.	Free HCl	Total	Total Acid	Inorganic Acid	Benz.	Description
Fast	29	0	0	10	0	++	Yel. Muc. Bld.
Alc. 20"	20	+	6	21	0	++	Yel. Less Muc.
Alc. 40"	17	−	0	10	0	−	Yel. Less Muc.

Duodenal Contents: Alkaline, yellow; somewhat viscid with some solid matter. After centrifugation no red blood cells or white blood cells were found. Occasional epithelial cells and numerous organisms were seen on smear.

After these studies, the patient was discharged. He did not consider his complaints sufficiently severe to warrant his return to the Out-Patient Department. We have recently communicated with the patient and he is in excellent health.

CASE II. A white male, aged forty-four entered the hospital acutely ill, with symptoms suggesting cholangitis. Three years before he had had a cholecystenterostomy because of obstruction of the common duct. At that time it was thought that the obstruction was due to carcinoma of the head of the pancreas. He made a good recovery and for three years led a fairly normal life. He then had a recurrence of his symptoms and was admitted to the hospital on January 28, 1932. The patient ran a very septic course and it was thought that his symptoms were due to cholangitis rather than to neoplasm. On this basis an exploratory laparotomy was performed on February 20, 1932. No evidence of carcinoma of the pancreas was found. The common duct could not be isolated because of dense adhesions. The anastomosis was closed and cholecystostomy performed. His subsequent course was progressively worse and he died on the nineteenth postoperative day.

The results of the roentgen studies made on this patient are of interest in comparison with those of Case I.

A cholecystogram was made but the gallbladder did not visualize. The films, however, revealed the bile ducts to be outlined with gas

from the gastrointestinal tract (Fig. 3). Examination of the stomach revealed no abnormality save the filling of the gallbladder through the surgical fistula which was readily identified (Fig. 4).

DISCUSSION

The outlining of the bile ducts and gallbladder with a contrast agent may occur in two ways: by regurgitation through a fistula between the gastrointestinal tract and the biliary system, or by reflux through the ampulla of Vater. In Tables I, II, and III we have summarized the reported cases of roentgen visualization of the biliary tree.

The clinical diagnosis of spontaneous internal biliary fistula depends upon the visualization of the bile ducts or gallbladder by roentgen examination. The number of such cases diagnosed by roentgen examination is very small compared with the number of such cases found at operation or at autopsy. From the time that Carman and Miller[7] described the first case in 1917, only 29 cases have been reported. Of these cases (Table I) 50 per cent have been associated with gallbladder disease, 25 per cent with duodenal ulcer, and a few with neoplasm.

FIG. 3. Case II. Gas in hepatic ducts.

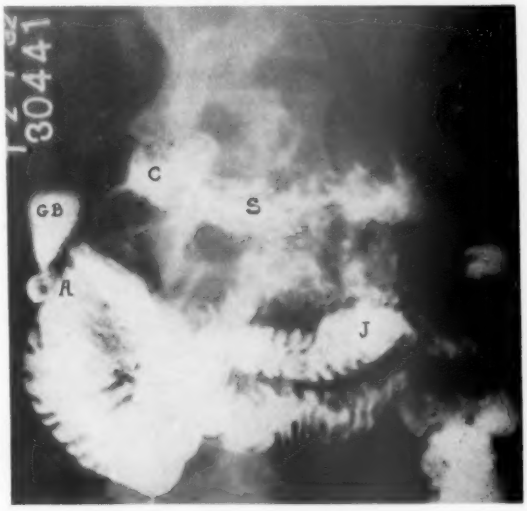

FIG. 4. Case II. Barium filling gallbladder through surgical fistula. GB—gallbladder. C—duodenal cap. S—antrum of stomach. J—jejunum. A—site of anastomosis.

Case I is unique in that there was no definite suggestion of gallbladder disease, ulcer or neoplasm. Kantor and Jaffin[26] have pointed out that the symptoms of one or more attacks of biliary colic followed by long remissions are found in many cases of internal fistula associated with gallbladder disease. The similarity of complaints in these cases is of interest but is of little value of making a differential diagnosis.

The diagnosis of reflux through the ampulla of Vater is difficult to establish on the basis of the roentgen examination alone. As shown in Table II, but 10 cases have been reported as such. Of these, surgical or postmortem verification was obtained in 5. From the available data, it would be difficult to eliminate positively the possibility of a fistulous tract in the remaining 5. In view of these facts, we feel that the visualization of the biliary tree is better explained on the basis of fistula than of reflux through the ampulla, when the diagnosis rests solely upon roentgen examination. A similar conclusion is reached by Arntzen[1] in a recent paper.

There are but 14 reports in the literature of the roentgen visualization of the bile ducts following surgical anastomosis of the

TABLE I

CASES REPORTED AS SPONTANEOUS INTERNAL BILIARY FISTULAE

No.	Author	Sex	Age	Presumptive Cause	Verification
1	Carman and Miller (1917)	—	—	Carcinoma of stomach	—
2	Busi (1919)	—	—	Cholelithiasis	
3	Stephenson (1921)	M	56	Duodenal ulcer	None
4	Havlicek (1925)	F	61	Cholelithiasis*	
5	Judd and Burden (1925)	—	—	—	
6	Haenisch (1926)	—	—	Cystic duct stone	Surgical
7	Habbe and Smith (1926)	M	70	Cholelithiasis*	None
8	Kantor and Jaffin (1928)	M	29	Duodenal ulcer	
9	Kantor and Jaffin (1928)	F	63	Cholelithiasis*	
10	Gavazzoni and Jona (1928)	—	—	Cholelithiasis	
11	v. Friedrich (1929)	—	—	Cholecystitis	Surgical
12	Martinotti (1929)	—	—	—	Surgical
13	Odischaria (1929)	M	40	Cholecystitis*	Surgical
14	Öhnell and Lindblom (1929)	F	61	Cholelithiasis*	Surgical
15	Reich (1929)	—	—	Cholelithiasis	
16	Harding (1929)	—	—	Duodenal ulcer	Surgical
17	Dalsace (1930)	F	52	Cholelithiasis*	Surgical
18	Fuller (1930)	F	69	Cholelithiasis*	
19	Gråberger (1931)	F	70	Cholecystitis	
20	Jenkinson and Brouse (1931)	M	59	Right upper quadrant pain, no jaundice	Surgical
21	Crane (1931)	M	80	Cholelithiasis	Surgical
22	Meldolesi (1931)	—	—	Duodenal ulcer	Surgical
23	Bignami and Agati (1931)	M	54	Duodenal ulcer	None
24	Buisson (1931)	—	—	Cholelithiasis*	Surgical
25	Lewin (1932)	F	72	Duodenal ulcer	
26	Lewin (1932)	—	—	Duodenal ulcer	
27	Beutel (1932)	F	55	Carcinoma of gallbladder	Autopsy
28	Rankin (1932)	F	56	Cholelithiasis*	Surgical
29	Arntzen (1932)	F	61	Cholelithiasis*	None

* Typical history

biliary and gastrointestinal systems. Such cases being of little interest from the diagnostic standpoint are probably less frequently reported. On the other hand, roentgen examination is not always successful in demonstrating more than the immediate site of the anastomosis. Rybak,[42] after an extensive review of the literature,

TABLE II

CASES REPORTED IN WHICH ROENTGEN VISUALIZATION OF BILE DUCTS IS ASCRIBED TO REFLUX THROUGH THE AMPULLA OF VATER

No.	Author	Sex	Age	History or Associated Pathology	Verification
1	Beall and Jagoda (1921)	F	42	Pancreatic abscess	Surgical
2	Fishbaugh (1926)	F	67	Tumor of pancreas	Autopsy
3	Sighinolfi (1926)	—	—	Cholelithiasis*	
4	Davis (1929)	F	—	Ca. of stomach	No statement
5	Davis (1929)	F	51	R.U.Q. colic, no jaundice	No statement
6	Venables and Briggs (1929)	—	—	Common duct stone	Surgical
7	Venables and Briggs (1929)	—	—	Recurrent ca. colon	Surgical
8	Reimann (1930)	—	—	Cholecystitis*	No statement
9	Jenkinson and Brouse (1931)	F	53	Cholecystitis*	No statement
10	Nemours-Auguste and Jahiel (1932)	F	—	Cholecystitis	Surgical

* Typical history

states that the visualization of the biliary tree is unusual. In the majority of such cases roentgenoscopic examination will reveal the site of the anastomosis, and perhaps the gallbladder and some of the larger bile ducts. A complete outline of the biliary system is not commonly seen.

bladder may reveal sufficient gas in the hepatic ducts to establish the diagnosis, as has been reported by von Friedrich,[14] Odischaria, [34] and Öhnell and Lindblom.[35]

TABLE III

REPORTED ROENTGEN STUDIES OF CASES HAVING SURGICAL ANASTOMOSIS OF GASTROINTESTINAL AND BILIARY SYSTEMS

Author	No. of Cases	Type of Anastomosis	Degree of Visualization of Biliary System during Gastrointestinal Series
Case (1916)	2	Cholecystenterostomy	Gallbladder only
Ralphs (1922)	1	Cholecystogastrostomy	Gallbladder only
Gulecke (1923)	1	Cholecystogastrostomy	Extrahepatic ducts
Hoseman (1923)	1	Cholecystoduodenostomy	
Lenk (1925)	1	Cholecystoduodenostomy	Entire biliary system
Mallet-Guy and Beaupere (1926)	5	Cholecystogastrostomy	Gallbladder only; air and barium at site of anastomosis and in longer ducts
Hüther (1927)	2	Cholecystogastrostomy	Not extensive
Orth (1928)	1	Cholecystogastrostomy	Gallbladder only
O'Bannon (1928)	1	Cholecystogastrostomy	Fistulous tract only
Swalm and Manges (1929)	1	Choledochoduodenostomy	Entire biliary system
v. Friedrichs (1929)	1	Cholecystoduodenostomy	Visualized ducts with gas
Parade (1930)	1	Cholecystoduodenostomy	Entire biliary system
Fetzer (1930)	1	Choledochoduodenostomy	Entire biliary system with barium and air
Rybak (1931)	1	Cholecystogastrostomy	Barium in gallbladder only

The majority of spontaneous internal biliary fistulae occur between the gallbladder and the duodenum (Judd and Burden).[25] Hence one would not expect the administration of gallbladder dye to result in visualization of the gallbladder. The procedure was employed in 11 of the 39 cases reviewed in Tables I and II, and in no case was the gallbladder shown. However, examination of either stomach or gall- We have observed similar results in Case II (Fig. 3).

SUMMARY

1. A case of spontaneous internal biliary fistula which was diagnosed by means of roentgen examination of the stomach is reported.

2. An example of the usual roentgen findings after the establishment of a surgical fistula between the gallbladder and the gastrointestinal system is presented.

3. The literature is reviewed.

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ROENTGEN VISUALIZATION OF THE PLACENTA*

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ROENTGEN visualization of the placenta in utero is important from a clinical as well as a theoretical point of view. Katsuya[3] and Ehrhardt,[2] working independently, recently accomplished this in animals by injections of divided doses of thorium dioxide sol. At the same time, the liver and spleen were shown. These structures are rich in reticulo-endothelial cells which store the injected material. They were cautious in recommending its use in humans because of its toxicity. Lewisohn,[4] using the same substance in animals and humans for the roentgen study of the spleen and liver, showed that it was stored as small granules in the reticulo-endothelial cells. Where a sufficient amount had been injected to give distinct roentgenographic shadows, there seems to have resulted an overloading of the cells resulting in nuclear damage. However, in later periods, repair was noted. Stewart, Einhorn, and Illick[5] report unfavorable reactions from its use.

Recently Campbell et al,[1] in a survey of contrast media in gynecology and obstetrics, mentioned the use of strontium iodide for visualization of the placenta in utero. They say that they insert the needle through the abdominal and uterine walls. If blood is aspirated, they puncture to the other side because of the likelihood that the placenta has been entered. They claim that no bad results ensue from this procedure as may happen when sodium iodide is used.

We have been able to demonstrate the placenta in the routine roentgen examination of the abdomen of pregnant women in a very high percentage of cases. In fact, we believe that with a reasonable amount of technical accuracy in making the exposures, no difficulty will be encountered. The placenta was not seen heretofore because we did not look for it.

When Snow first recognized the placenta on the film, he showed the cases to several obstetricians. They have been disinclined towards intrauterine injections of opaque substances through the abdominal wall for fear of untoward results; and they were very enthusiastic, because, having seen a few cases, they were readily able themselves to locate the placenta in succeeding cases.

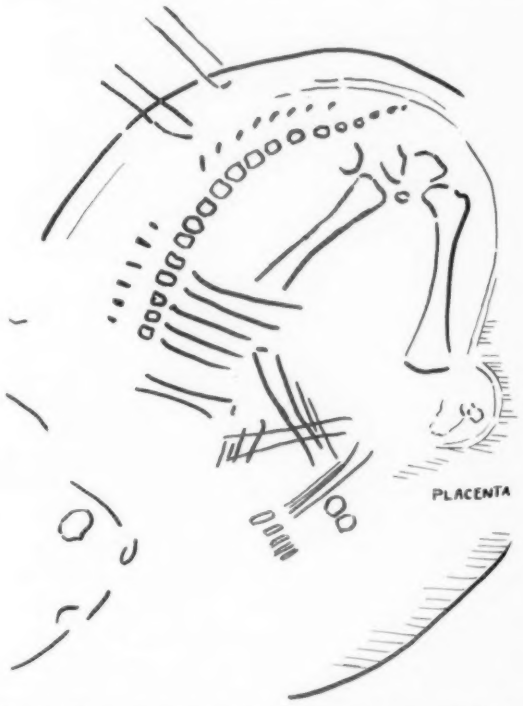

FIG. 1. Vertex presentation. Placenta low anteriorly. Note pressure defect in it by fetal leg. Placental shadow fuses with that of uterine wall. Thickness of uterine wall seen at fundus.

TECHNIQUE

In our cases, no special technique was used. We studied the latest 60 pregnancy cases that were routinely examined. In most instances, we had an anteroposterior and lateral view.

* From the X-Ray Departments of the Harlem and Bronx Hospitals, New York City.

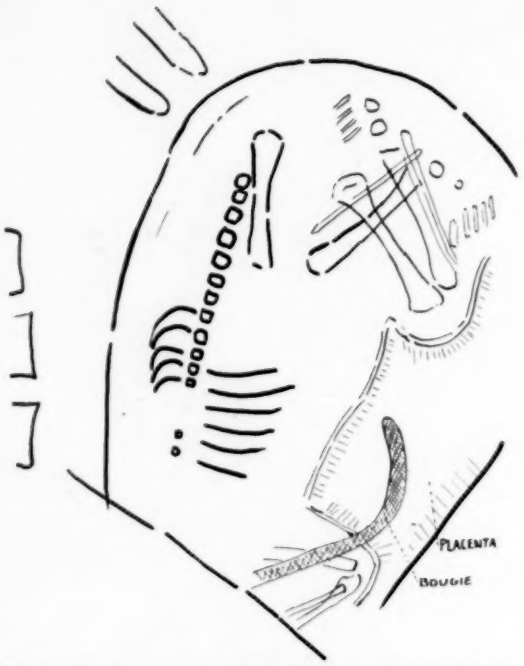

FIG. 2. Vertex presentation. Placenta low anteriorly. Note pressure defect in it by fetal knee and elbow. Double line between fetal parts and placenta is seen as a black line on film, and is caused by subcutaneous fat of fetus.

FIG. 3. Vertex presentation. Placenta anteriorly.

DESCRIPTION OF FINDINGS

In the cases studied, the most frequent site of the placenta was at or near the

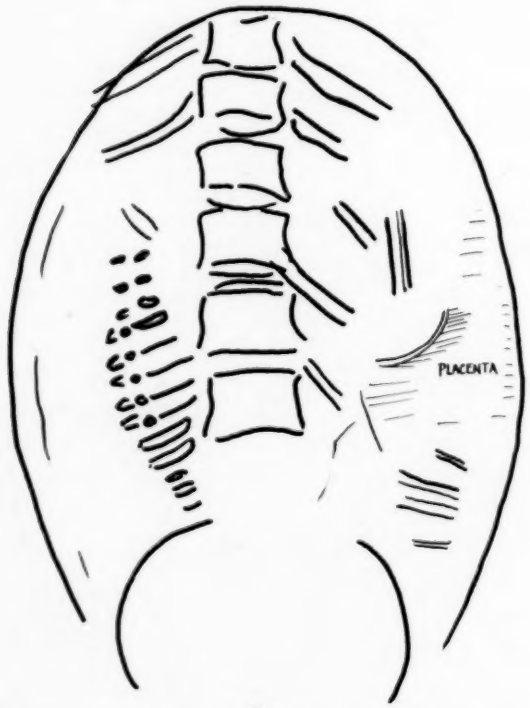

FIG. 4

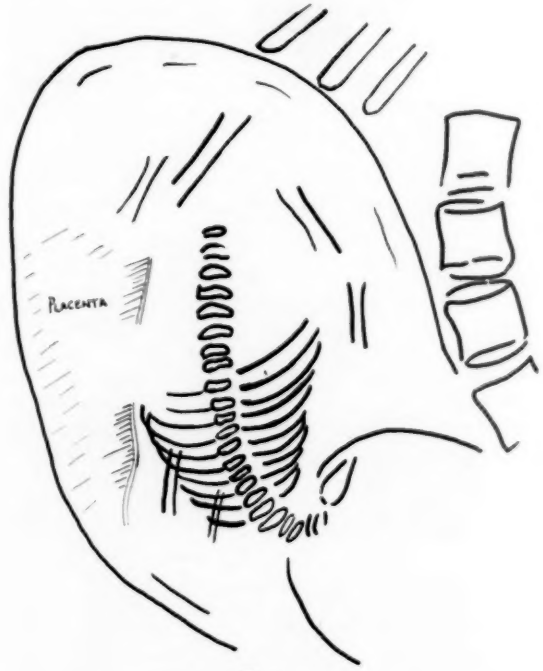

FIG. 5

FIGS. 4 and 5. Vertex presentation. On lateral view (Fig. 5) placenta seen anteriorly; on anteroposterior view (Fig. 4) seen to right. Placenta, therefore, situated anterolaterally to the right.

fundus. A much smaller proportion was lower down. This conforms with the observations of the obstetricians. It occupies about one-third of the wall space of the uterus, bulging in the middle and tapering at the periphery toward the uterine wall. The bulge varies with the angle at which the examination is made. On edge, it measures about 7 cm. In practically all cases,

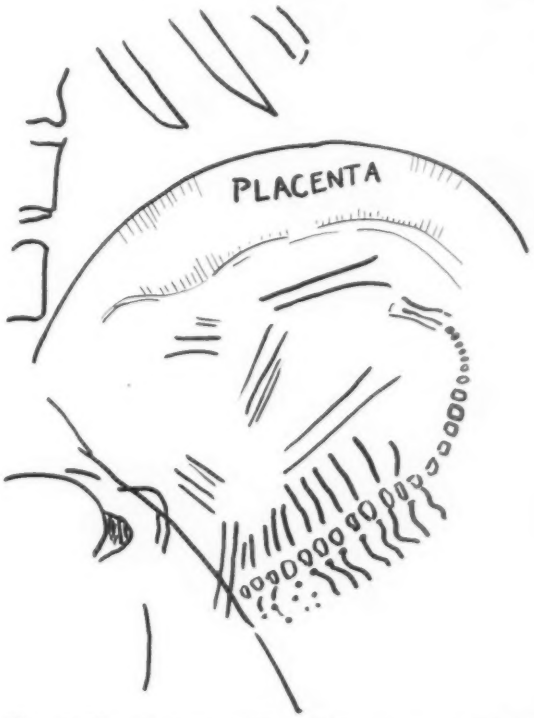

Fig. 6. Vertex presentation. Placenta near fundus posteriorly. Double line indicates greater width at fetal buttocks where subcutaneous fat is more abundant.

the ventral part of the fetus faces it. In no instance was the fetal back flush up against it. This appears to be natural because the placenta is very compressible and the relatively broad smooth back of the baby might disturb the placental circulation. Very often, a knee or elbow causes a pressure defect in it. When a part does abut on it, a line of increased density appears between. For the elbow, it is usually about 2 mm., for the knees about 3 mm., and for the buttocks as much as 1 cm. It is our belief that this is caused by the greater penetra-

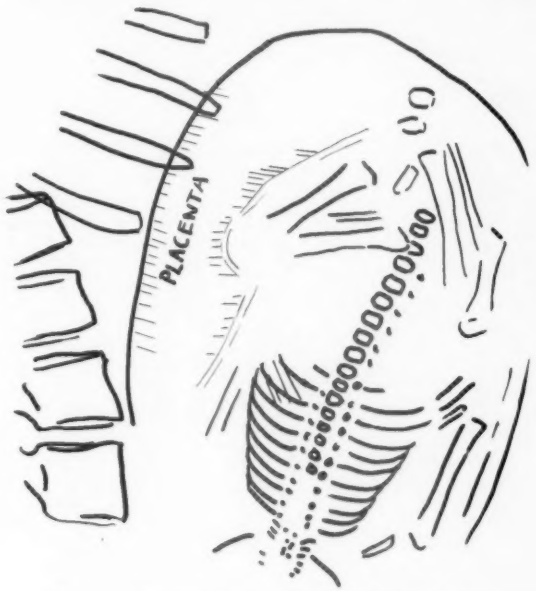

Fig. 7. Vertex presentation. Placenta near fundus posteriorly.

bility by roentgen rays of the fat containing subcutaneous tissues. Incidentally this finding is often helpful in locating the placenta (see tracings).

The question arises as to how to differentiate between the placenta and amniotic fluid. In the first place, the placental

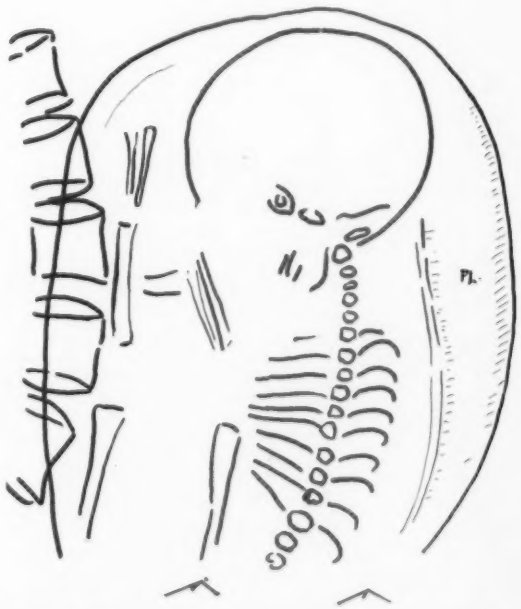

Fig. 8. Breech presentation. Placenta anteriorly.

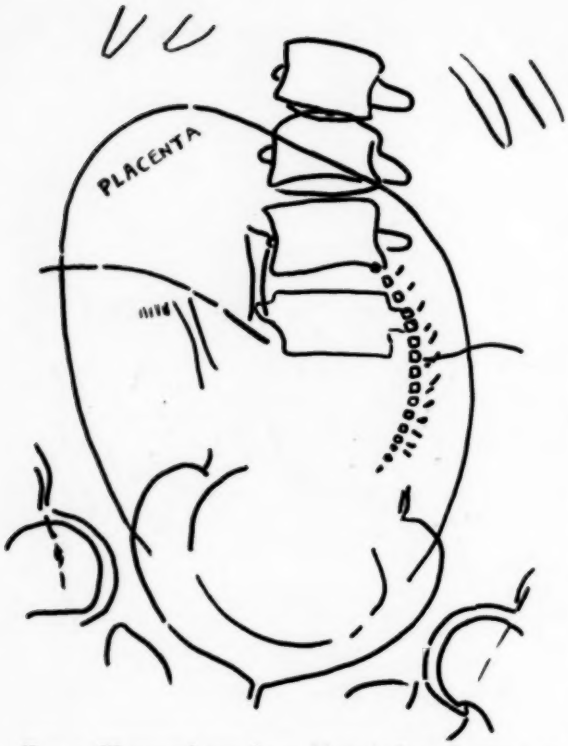

FIG. 9. Placental apoplexy. Note bulge of uterus at site of placenta.

shadow fuses with that of the uterine wall. In the second place, the placenta, consisting of tissues and blood, causes greater obstruction to the roentgen rays than the amniotic fluid, which is of low specific gravity. Hence, the latter casts a blacker shadow.

In some cases, the bruit of the placenta was located by use of the stethoscope. This corresponded with the roentgen findings.

The final proof of this observation will be established by operation or autopsy, and with the use of contrast media and roentgenograms. Despite the lack of these studies, we feel certain as to the accuracy of our observations.

APPLICATION

We have not seen cases of placenta praevia, but it is fair to assume that with the proper clinical findings, the visualization of the placenta very low or not at all, would help greatly in establishing the diagnosis.

Many obstetricians are coming to the belief that it is a wise procedure to examine a patient roentgenologically before performing a cesarean section. It would be of assistance to the operator to know the site of the placenta.

If, in the future, the procedure of injecting some radiopaque substance into the uterine cavity for diagnosis becomes definitely established, it will be logical to make a preliminary roentgen examination. This will guide one in selecting the site through which the needle should be inserted. Greater information will probably result from the findings before and after injection than from one method alone.

In 3 cases of placental apoplexy examined, one showed a distinct bulge of the uterus at site of the placenta. Williams,[6] in his book, says that in some cases this can be determined by palpation, but it is not always present. A similar picture resulted from large fibroids. In one case, the fetus was displaced to the left, and, in another, the fetus was displaced upward. Therefore, in order to establish a correct diagnosis, the clinical information is essential.

Other applications, such as the diagnosis of tumor or cyst of the placenta, will suggest themselves as the problems arise.

Addendum: Since this paper was sent in for publication we have observed several cases that were verified at operation.

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ROENTGENOLOGICAL EXAMINATION OF THE CHEST IN LATERAL DECUBITUS

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IN 1931 Rigler[1] described a new position in the roentgenological examination of the chest for the demonstration of small pleural effusions. This new position consists in placing the patient on the affected side with the film in front and the roentgen tube behind. An important feature in the technique, according to Rigler, is to bring the film itself to the very margin of the chest wall on the inferior side. For this purpose he raises the patient above the level of the table by cushions under the shoulder and hip. In this way the cassette may drop an inch or two below the level of the patient's body and will rest on the table with the upper arm of the patient around it, thus giving it the necessary support in holding it in the vertical position.

This new position was used on a number of patients with very satisfactory results in demonstrating small effusions in the pleural cavity as well as large effusions which appeared to be small in the usual anterior upright position. Its greatest usefulness, however, was demonstrated when the patient was placed on the unaffected side. In this position the heart shifts toward the healthy side thus exposing the unhealthy side to a more satisfactory inspection. The value of this position was also proved in cases of hydropneumothorax.

Three cases are chosen in order to illustrate the points raised in the preceding paragraph and will be described in more or less detail.

[1] Rigler, L. G. Roentgen diagnosis of small pleural effusions; new roentgenographic position. *J. Am. M. Ass.*, 1931, *96*, 104–108.

FIG. 1A. Anterior upright position. Right costophrenic and cardiophrenic angles are obliterated due to fluid in the pleural cavity.

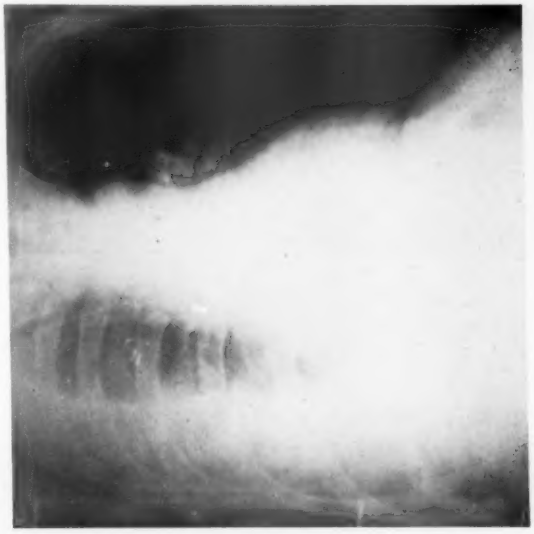

FIG. 1B. Right lateral decubitus position. The fluid occupies the entire periphery of the right chest.

CASE 1. This patient was admitted to the hospital with symptoms indicating pleurisy on the right side. A roentgen examination of the chest in the upright anterior position (Fig. 1A)

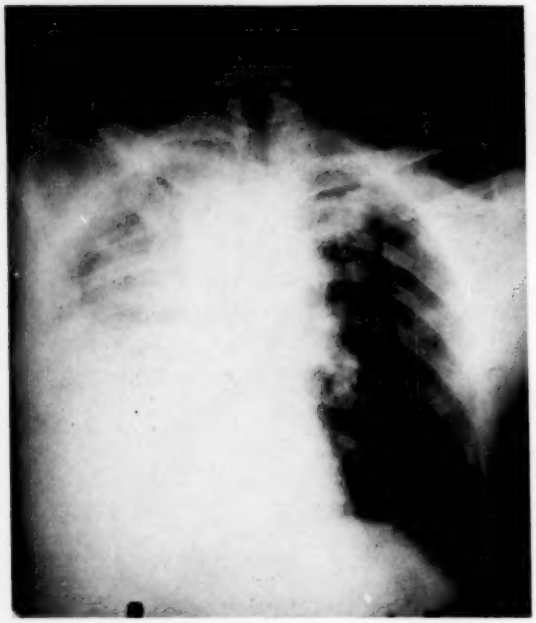

FIG. 2A. Posterior recumbent position. The right chest is obscured by a dense shadow apparently due to fluid. Heart is displaced to the right side.

showed obliteration of the right costophrenic and cardiophrenic angles apparently as a result of fluid in the pleural cavity. The impression obtained from this view was that the amount of fluid in the pleural cavity was small. In the right lateral decubitus position which is the affected side in this case (Fig. 1B) the fluid was seen to occupy the whole of the periphery of the right chest at a considerable elevation. This view proved that the fluid was not encapsulated and was freely movable. It also impressed one that there was a good deal more fluid in the pleural cavity than was suspected in the first view.

CASE II. This patient was admitted to the hospital with a clinical and physical diagnosis of a probable pleurisy on the right side. In a posterior view of the chest in the recumbent position (Fig. 2A) the right side appeared to be almost entirely obscured by a dense shadow apparently due to fluid in the pleural cavity, but unlike a pleurisy with effusion the heart was found displaced to the affected side as is the case with pulmonary atelectasis. With the patient placed in left lateral decubitus position, which is the healthy side in this case, the heart shifted toward the left side (Fig. 2B). The right side being freed from the heart shadow presented quite a different appearance both in the lung and pleura. It was evident that the whole of the right chest was not occupied entirely by fluid. Only the periphery of the chest just above the diaphragm presented an encapsulated empyema and a smaller one in the axillary region. Operation confirmed the diagnosis.

CASE III. This patient was admitted to the hospital with a clinical and physical diagnosis of pleurisy with effusion on the left side. An anterior view in the upright position (Fig. 3A) showed the presence of a hydropneumothorax on the left side. The heart was found displaced considerably toward the right side. In the right lateral decubitus position, which is the healthy side in this case (Fig. 3B), a horizontal line indicating the level of the fluid was shown parallel with the spine. Above the line the air accumulated, thus exposing the periphery of the chest to a more accurate inspection which revealed nodular shadows of soft consistence just above the diaphragm. The diagnosis of a probable endothelioma of the pleura was later confirmed by a post-mortem examination.

In place of cushions for the elevation of the patient above the table a simple apparatus has been utilized during the past

FIG. 2B. Left lateral decubitus position. The heart is shifted to the left side. The periphery of the right chest shows two dense shadows, one above the diaphragm and one in the axillary region due to encapsulated empyemas.

nine years. This apparatus (Fig. 4) consists of an elevated platform which measures 14×17 inches in diameter and is about 2 inches above the table. On one side there is a groove which is large enough to accommodate the average thickness of a standard cassette in the vertical position. The cassette being firmly held in the groove requires no assistance on the part of the patient or attendants. The patient's thorax is placed on the left or right side, depending upon the object sought, with either the dorsal or ventral surface of the thorax against the cassette. The roentgen tube is adjusted at right angles to the cassette.

Fig. 3a. Anterior upright position. Left chest presents a hydropneumothorax. The heart is displaced to the right side.

Fig. 3b. Right lateral decubitus position. The periphery of the chest and diaphragm is free from fluid. Nodular shadows are noted above the diaphragm. The diagnosis of endothelioma of the pleura was confirmed by a post-mortem examination.

CONCLUSIONS

1. The advantages of the lateral decubitus position in the examination of the chest for pleuritic affections has been fully confirmed. Both small and large effusions can be demonstrated to greater satisfaction.

2. The use of the lateral decubitus position with the patient placed on the unaffected side has been found of greater diagnostic value than the placing of the patient on the affected side. In this position the heart shifts toward the healthy side, thus exposing the unhealthy side to more accurate inspection.

3. A simple apparatus of easy construction is described which serves as a support for the thorax above the level of the table as well as a support for the cassette in the vertical position.

Fig. 4. Apparatus for elevating the patient above the table and supporting a cassette in the vertical position.

A ROENTGEN EXAMINATION REPEATED AFTER THIRTY YEARS*

A CASE REPORT OF A SHELL-SHATTERED BONE WITH ROENTGENOGRAMS MADE IN 1899 AND 1929

By ALFRED H. HEALD, M.D.
SAN FRANCISCO, CALIFORNIA

AN "x-ray photograph" from a family album and a roentgenogram made of the same part after an interval of thirty years have some pathological as well as historical interest. In my childhood I was often shown the picture of the "inside of Uncle Ed's wounded leg," and told the story of how and why the picture was taken. Three decades after the first x-ray picture of the injured leg was made, the opportunity offering itself, curiosity prompted the taking of the second roentgenogram.

FIG. 1. Roentgenogram of wounded left leg made in 1899.

CASE REPORT

E. H., aged twenty-five, was struck in the left leg by an explosive bullet while in action with the South Dakota Volunteer Infantry near San Fernando, P.I., in May, 1899. The brass jacket of the bullet and many fragments of bone were removed from the wound. The infected wound failed to heal, and, refusing amputation, the soldier was finally invalided to his home with a discharge diagnosis of: "Bullet wound left leg—tibia shattered, fibula fractured."

At home in Hawarden, Iowa, his family phy-

FIG. 2. Roentgenograms of wounded left leg made in 1929.

* From the Department of Roentgenology, University of California Hospital, San Francisco.

sician, Dr. J. H. Brower, was the proud possessor of a Toepler-Holtz glass plate electric generator and one of the first focus-type x-ray tubes. (A Jackson modification of the Crookes tube which Roentgen had used in the discovery of the x-ray only four years before.) In November, 1899, six months after the wound was received, the "x-ray photograph" (Fig. 1) was produced in Dr. Brower's office. A local photographer was on hand to assist with the photographic details and the patient's father turned the hand-crank which rotated the glass plates of the friction generator. The first fifteen-minute exposure brought forth a rather imperfect picture in which all details were obscured because of failure of the subject to "hold still." After more heroic strap and sandbag immobilization of the patient and his leg, fifteen more minutes' hand-turning of the generator resulted in the roentgenogram reproduced here.

The early roentgenogram was apparently correctly interpreted as showing bone healing and repair, and after further operative cleansing with the removal of a few metallic fragments, the wound healed. Except for lameness in gait, probably due to muscle damage, the leg has remained functionally strong and sound.

The roentgenogram of 1899 shows the many irregular metallic fragments in the soft tissues, the destructive lesion of the tibia and the calcified subperiosteal callus upon the fibula. The shaft of the tibia is regenerating along its median aspect. This eccentric regeneration of the shaft is probably due to the destruction of periosteum and endosteum on the lateral aspect of the bone within the major site of the wound.

The roentgenogram taken thirty years later (Fig. 2) shows many metallic fragments still remaining in the wound. The eccentric regeneration of the shaft of the tibia forecast in the earlier picture now shows clearly. Irregular inflammatory bony spurs are seen attached to both the tibia and fibula at the site of the wound. The roentgenogram speaks volumes for the inability of bone to adequately regenerate and reshape itself in a region where periosteum and endosteum are destroyed and replaced by scar tissue. The regenerating tibia may have been forced to arch out over the heavy foreign body scar undoubtedly present in the wounded region between the bones.

ROENTGEN IRRADIATION IN THE TREATMENT OF MAMMARY CARCINOMA*

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EVER since roentgen irradiation was first employed in the treatment of malignant diseases, many methods of technique have been utilized. These have varied not only according to individual preference based upon personal experience, but also with the advances made by improvement in apparatus and by increased knowledge of the physical properties of the rays, which has resulted in more exact measurements of dosage and in better understanding of the reaction of tissues to irradiation. There is now available for therapeutic purposes a very wide range of wave lengths of radium and roentgen rays (from 0.002 to 2.0 Ångströms) which can be produced at will and can be measured in recognized, standard units of quality and quantity. On the basis of this accurate information, it has been learned by experience and experiment that each type of tissue may be expected to react to irradiation in a certain specific way. It has been shown in vitro that each type of tumor tissue can be completely destroyed by a specific dose of roentgen rays, and if less is given, there is proportionately minimized destruction. Some growths respond to comparatively small doses, while others require enormous doses which could not be administered in vivo. With the cooperation of pathologists, radiologists are becoming familiar, not only with the manifestations of tissue reactions, but also with the types of neoplasms which are radiosensitive.

However, although we can measure the dosage of radiation exactly, and know the types of neoplasms which can be expected to respond favorably to the doses which we can administer, we are still ignorant of the influences of the environment in which a neoplasm originates and grows. By the environment of a tumor, I mean the conditions which surround it and influence its life. These include the reaction of the tissue bed to the growth, which, in turn, depends upon the physiologic processes of the host. It is because of the differences in environment or physiologic response that a certain type of tumor may be highly malignant in one individual and comparatively benign in another. Every radiologist has had the experience of treating successfully a particular type of neoplasm by a specific dose of radiation, only to fail completely in a case apparently exactly similar. Some examples of this influence of environment on neoplasms may be cited. It is a well-known fact that most malignant diseases are rapidly fatal in a young person, as a rule, while an older individual with the same type of disease may survive. Another interesting influence of environment upon the rate of growth of malignant diseases and the effect upon the host is seen when a carcinoma develops in a lactating breast or in a pregnant uterus. In either case, the woman is doomed, because a growth stimulus is developed in and by the physiologic processes of the individual under these circumstances. Still another adverse circumstance for the patient is established when acute inflammation exists in or about an area of malignant disease, in which case the normal physiologic processes of resistance to infection disturb those which are reacting on the neoplasm, allowing it to grow without restraint.

It is certainly impossible to determine at this time just what physiologic processes constitute or produce restraining or stimulating influences on the development of neoplasms; indeed, some may doubt this possibility. However, it is interesting to note a system of classification of tumors as to the degree of malignancy (Broders')

*Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept., 27-30, 1932.

which is partly based upon the manifestations of the local reactions in and surrounding neoplastic cells. These reactions of cellular infiltration and fibrosis, in the environment of the growth, are the same reactions produced by any sort of degenerative process which may take place in tissue.

On the basis of this hypothesis that the environment is responsible for the rate and character of neoplastic growths, it is easy to appreciate why, with present therapeutic methods, it is impossible to relieve all patients with malignant disease. We can predetermine fairly accurately the type and the extent of the growth, we can remove most or all of it, we know its degree of radiosensitivity and can often apply a definitely measured dose of radiation which experience tells us should eradicate it, yet there is no basis on which we can predetermine the influence on the neoplasm of its environment, and it is on this unknown factor that the results of treatment often depend. Irradiation produces degeneration in malignant tissue not only by direct effect upon the neoplastic cells but also indirectly by the reaction of the normal tissue to the irradiation and to the degenerative processes thus established.

Direct stimulation of the growth of neoplastic cells never occurs following irradiation. However, I believe that it is possible to produce or inhibit certain reactions in the normal tissues, or to disturb by irradiation the natural physiologic processes, so that normal barriers to malignant disease, which might have been established by the host, may be destroyed, thereby permitting more rapid development of the neoplastic cells already present.

This was proved to me a number of years ago, after some experience with the the new deep roentgen therapy. I became convinced that the results obtained by intensive crossfire postoperative irradiation of mammary carcinoma were less favorable than the results with the older technique using lower voltage and less filtration. A review of the cases confirmed this conviction, and I found that other radiologists also had had the experience of finding that malignancy recurred and metastases developed sooner and more often than when less intensive roentgen treatment, or none at all, was given. The fact that local recurrences and metastases did develop more rapidly in a larger number of cases meant to me that neoplastic cells, which often remain after radical removal of the carcinomatous breast, might subsequently be inhibited or destroyed by physiologic processes or

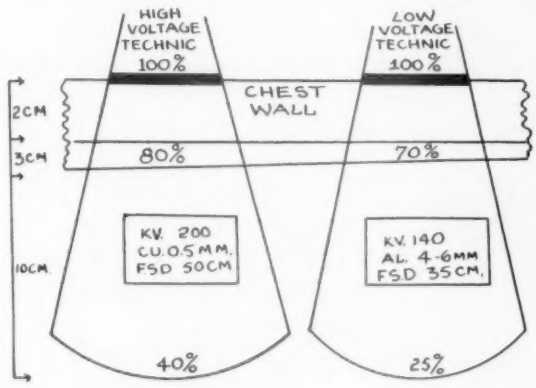

Fig. 1.

by mild irradiation during the early stages of their development, but that intensive irradiation by the crossfire method broke down the normal barriers so that the neoplasm developed more rapidly. I attributed this, not entirely to reactions produced locally by the radiation, but also to the destruction of the cellular elements of the blood which received a very large dose of rays at the time of treatment, while circulating through the heart and lungs. After discontinuing this intensive crossfire technique and employing more conservative methods the results have improved and are comparatively much more satisfactory.

The comparison of the results obtained by the two methods of treatment is shown in Table 1.

These facts and observations of apparent damage in other types of cases treated by massive doses of roentgen rays indicate that too much zeal may result in interference with growth-inhibiting physiologic processes and that our efforts in radiation

therapy should be not only to destroy neoplastic tissues but also to protect the patients by building up or assisting their normal resistive influences.

TABLE I

RESULTS OF INTENSIVE POSTOPERATIVE ROENTGEN THERAPY FOR MAMMARY CARCINOMA SERIES TO 1924

	Recurrence or Metastases 1 yr.			Alive 5 yr.		
	Not irradiated per cent	Light irradiation per cent	Intense irradiation per cent	Free of cancer	With cancer	All cases
Compiled from literature	25	37	45			
Cleveland Clinic series 92 cases	16.5	20	35			
103 Consecutive cases Modified technique 1931		20		42.7	7.8	50.0

An examination of massive cross-sections of the entire carcinomatous breast often shows cords and masses of neoplastic cells, not only in the immediate proximity of the primary focus and extending directly from it, but also isolated areas of disease in the gland, fat, muscles, fascia and lymphatic vessels and nodes. Therefore, the entire mammary gland and the surrounding and connecting tissues should be considered involved in every case. It can be shown microscopically that the axillary lymph nodes are involved in 85 per cent of cases in which operation is done. This conception of the widely invasive nature of the disease should be the basis for determining upon the operative technique and subsequent treatment of mammary carcinoma. The operation should remove as much tissue as is technically possible. In this connection, I have observed more local recurrences and invasion of the skin by malignant disease in obese patients than in others, because surgeons are prone to make standardized incisions or excisions of about the same size and shape regardless of the configuration of the chest or the location

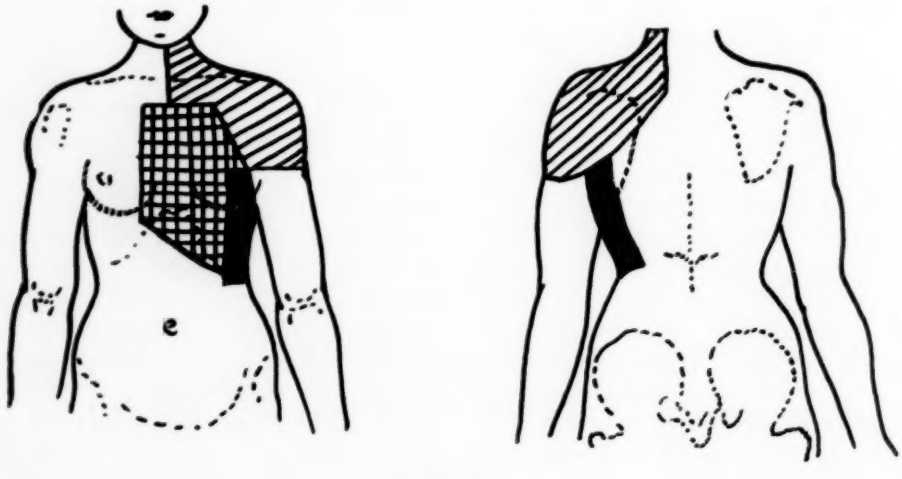

FIG. 2.

I believe that the latter is one of the chief functions of roentgen therapy in the treatment of malignant diseases. We know by experience and through a vast amount of experimental evidence that usually we cannot administer sufficiently large intensities of roentgen radiation to eradicate malignant neoplasms. However, by judicious application of the rays we can inhibit many growths, offer palliation to many patients and occasionally effect a cure.

of the tumor, apparently trying to obtain a good cosmetic and functional result rather than taking into consideration the necessity for removing tissue which may be involved; hence not infrequently insufficient skin is removed. The necessity for removing large areas of skin is shown by the fact that metastases are more likely to develop in cases in which there is local recurrence of the growth.

In adopting a technique for postoperative treatment of mammary carcinoma it is necessary to take into consideration the type of growth, the usual anatomic lines of extension and invasion, and also those physiologic processes which may have to do with establishing barriers to the disease. Most carcinomas of the breast require larger doses of roentgen rays to destroy them than can safely be administered, although, fortunately, some cases seem to respond favorably to comparatively moderate doses. There is no criterion by which one can determine the influences of environment and which cases will be benefited, and this is the reason for advocating postoperative roentgen therapy as a routine procedure. Undoubtedly more patients will derive no benefit than will be relieved; however, this does not constitute a valid argument against the method.

The technique of treatment should be established on the basis of the type of tumor and of the anatomic configuration of the patient. After mastectomy the chest wall is from 2 to 3 cm. thick. If a high voltage technique is employed (200 kv.; filter 0.5 mm. Cu or more, at 50 cm focal skin distance) the dose at a depth of 3 cm. is approximately 80 per cent and at a depth of 10 cm., is 40 per cent of that administered. With a low voltage technique (140 kv.; filter 4 to 6 mm. Al, at 35 cm. focal skin distance) the dose at 3 cm. is still as high as 70 per cent, but at 10 cm. depth is only about 25 per cent. These figures indicate that the dose in the chest wall by low voltage technique is only slightly less than by high voltage, but the deep dose, or that which reaches the lung and heart, is much less. This is illustrated by Figure 1. The difference in the intensities of radiation absorbed in the chest wall with the high and low voltage techniques makes no appreciable difference as far as the destruction of neoplastic cells is concerned, but the larger dose by high voltage technique which penetrates into the organs within the chest certainly can do the patient no good, to say the least. Therefore, I am of the opinion that in the postoperative treatment of mammary carcinoma the irradiation should, so far as possible, be limited to the chest wall by a low voltage technique and complete surgical removal should be depended upon to eliminate the diseased tissue in this region. It is doubtful whether extensions of carcinoma along the internal mammary vessels or the peristernal lymph nodes can be affected by roentgen therapy. However, the disease probably does not take this course in a very large proportion of cases.

The most important region for the application of radiation is the axillary and supraclavicular canal in which the surgical removal of tissues is difficult, if not impossible, in most cases, and this is the usual line of extension and outlet for metastases. This field, omitting as much of the lung as possible, should be homogeneously irradiated anteriorly and posteriorly with high voltage and heavy filtration. Usually this entire area may be included in one field of irradiation, but the number, size and shape of the fields over the chest and lateral wall must be varied according to the configuration of the patient, as shown in Figure 2. The first course of treatment should be begun as soon as possible, preferably within a few days after operation. I give the low voltage fields 800 r each and the high voltage fields 1,000 and 1,200 r as measured on the skin. This dose produces a mild erythema in about three weeks. A second course is given when the reaction has subsided or in about three months, and a third four to six months after the second. Thus a total dose of from 2,400 to 3,000 r is given within less than a year after operation.

In conclusion, I want to repeat my be-

lief that our efforts in roentgen therapy should be directed not merely to an attempt at destruction of malignant processes by administering great intensities, but also to preserve and enhance the defense of patients against the invasion of the neoplasm by taking into consideration the environment of the growth as it is influenced by physiologic processes. With this in mind, in the postoperative treatment of mammary carcinoma, great intensities of radiation should be administered only to those areas which can withstand them and dosage over the chest wall should be modified to prevent damage to the organs of the chest and to the elements of the blood.

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IRRADIATION IN THE TREATMENT OF FIBROMYOMA OF THE UTERUS*

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FIBROMYOMA of the uterus is probably the most frequent gynecological lesion encountered. The autopsy records of Johns Hopkins Hospital showed an incidence of 33.7 per cent in all colored women over twenty, and 10 per cent in all white women over twenty years of age. Ewing[14] states that 50 per cent of all women over fifty, and 20 per cent of those over twenty-five have fibromyomas. This indicates that probably one-third to one-half of women reaching the age of forty have fibromyomas of the uterus of varying sizes. The presence of fibromyoma of the uterus, as Masson[32] has pointed out, does not necessarily mean that treatment is indicated, for in many cases the fibromyoma is small and is not producing symptoms. Oftentimes these cases receive no treatment or are simply kept under observation until the natural menopause is reached and involution occurs. Frequently, the patient suffers from menorrhagia or pressure symptoms which demand relief. In these cases two types of treatment are available: surgery or irradiation. Each enjoys certain advantages over the other. Certain cases have definite indications for surgical intervention, while irradiation is indicated in others. Both methods are beyond the experimental stages. Our interest lies chiefly in irradiation.

Irradiation in the treatment of uterine fibroids was first employed by Deutsch[13] in 1904. Foveau de Courmelles[16] reported his results in 1906 and 1907. One of us (Pfahler)[35] began treating these cases in January, 1906. Since then the literature has been abundant upon the subject of irradiation in the treatment of uterine fibroids. In 1914, Pfahler[35] collected from the literature over 1000 cases treated. Béclère[3,4] reported on this subject in 1913, in 1920, and again in 1922, the latter report being on 700 cases treated by him in which satisfactory results were obtained. Arnstamm and Nowotjelnowa[2] collected from the literature prior to 1928, 11,805 cases of uterine fibroids treated by irradiation. They found that satisfactory results were obtained in 90 to 98 per cent of these cases. Since then there have been further reports on rather large series of cases. Nemenow,[34] in 1929, reported on 470 cases treated by him with 98.4 per cent clinically satisfactory results. Gál,[17] in 1929, reported on 737 cases. Linton, Marks and Smith,[30] in 1929, reported on 250 cases with satisfactory results in over 98 per cent. Gambarow,[18] in 1929, reported on 800 cases with satisfactory results in over 90 per cent of the cases. Strassmann,[45] in 1929, reported on 503 cases with satisfactory results in 92.7 per cent. No attempt has been made to review all reports, but these five authors have reported, since 1928, on 2,760 personal cases with an average of 95 per cent cures.

Kelly[28] says:

> I place radium first in the list, far ahead of surgery, which occupies only a secondary place. After the exclusion of malignant conditions by curettage, and of lateral tubal and ovarian disease by a thorough examination, an intrauterine treatment is given with radium, associated perhaps at once with x-ray therapy through the abdominal walls. As a result of this treatment most fibroids shrink in a few months, perhaps a year, into innocuous small tumors, or even totally disappear.

Wood[51] says:

> Many uncomplicated fibromyomas are still removed surgically which could perfectly well be treated by roentgen irradiation. The advantages of the x-rays are the lack of risk, the simplicity of the treatment, the certainty of the results, and the low cost to the patient.

* Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27–30, 1932.

Stacy[41] states:

Radium, then, is the treatment of choice in cases of menorrhagia of menopause associated with fibromyomas not exceeding in size a four months' pregnancy, or of a fibrous uterus, in which the possibility of malignancy is eliminated by the history, or by a curettement.

Crile[12] says:

We are in accord with the conclusion of John G. Clark, that near, during or after the menopause, intramural fibroids of moderate size or fibrosis associated with hemorrhage should be treated by radium or radium plus deep x-ray therapy unless the tumor is sub-mucosal or sub-peritoneal, in which case, irradiation will probably fail.

Corscaden[11] says:

X-ray and radium furnish a safe method for the treatment of fibromyomas and uterine bleeding.

Other well-recognized authorities such as Polak, Norris, Anspach, Bland, Keene, and others too numerous to mention, advocate the employment of irradiation in selected cases for this condition. The results obtained by irradiation compare favorably with those obtained by the most skilled gynecologists by surgical measures. These results are dependent upon a careful selection of the cases, as follows:

Indications. Irradiation we believe to be the treatment of choice: (1) in all cases of fibromyoma in women near or beyond the menopause in which the tumor is no larger than midway between the symphysis and umbilicus, is not undergoing degeneration, and is not causing intolerable pressure symptoms; (2) in all patients in whom there is marked organic heart disease, diabetes, nephritis, pulmonary tuberculosis, or other constitutional conditions, which would contraindicate surgical removal; (3) in cases with large fibroids which cannot have an immediate operation on account of anemia. This opinion is shared by Burnam,[6] who has reported favorable results in fibroids of large size. It is also shared by Corscaden,[11] who has reported a reduction in the size of the fibromyoma as occurring in 96 per cent of the cases; in 55.2 per cent a complete disappearance; in 28.3 per cent, a reduction of 50 or more per cent; in 12.5 per cent, a definite but unimportant reduction; (4) in all cases in which operation is refused, for one cannot force an operation upon a patient. We refused irradiation in one case and the patient died of hemorrhage.

Contraindications. (1) Malignancy of the uterus or adnexa should be excluded so far as possible by a careful study of the history, by curettage, and a thorough pelvic examination, digitally and visually, for malignancy of the uterus requires a great deal more irradiation than is used for fibroids. (2) The tumor mass should not be larger than midway to umbilicus, unless operation has been refused or there is a definite contraindication to operation, in which instance one is justified in treating a fibromyoma of any size. (3) Pedunculated or submucous tumors are less favorable since these often cause a continuation of the bleeding after irradiation. (4) Large fibromyomas which are producing distressing pressure symptoms yield too slowly and are better treated surgically. (5) Fibromyomas which have undergone cystic degeneration or are gangrenous, if the diagnosis can be made, should be operated upon.

In younger women, in whom there is still hope and desire for subsequent pregnancy, a myomectomy is the treatment of choice. If operation is refused, or if because of adhesions, a myomectomy is impossible, treatment by irradiation is justified, protecting as far as possible, the ovaries. *It is possible to treat a uterine fibroid with roentgen rays without affecting the ovaries*, as is shown by the case presented on April 5, 1917, before the Philadelphia Obstetrical Society by Pfahler and McGlinn,[36] which we review very briefly as follows:

Patient, aged twenty-four, was referred to Dr. McGlinn, May 18, 1915, by Dr. George Millyer when she was five months' pregnant, because of excruciating pain in the sacral region, and aggravated nausea and vomiting. A diagnosis of pregnancy with incarceration was made, but at abdominal section

on May 19, 1915, a myoma the size of an orange was found growing from the posterior wall of the uterus, and completely filling the hollow of the sacrum. The family would not consent to a complete hysterectomy. *One week later she aborted an anencephalic monster.* On Sept. 22, 1915, after Dr. McGlinn outlined the exact location of the tumor, Dr. Pfahler gave roentgen treatment limited to the fibroid, protecting the ovaries. The fibroid disappeared. The menses remained regular, and as soon as sexual intercourse was permitted she became pregnant and gave birth to a normal healthy child. She has had two healthy children since.

The case is of special interest because the fibroid was cured by direct action of the roentgen rays upon the tumor, without affecting the ovaries. It is also of interest because the monster was born before any irradiation was given, while if it had occurred after irradiation the roentgen treatment would certainly have been blamed.

Another case of ours in which there was a fibromyoma the size of a grapefruit received roentgen therapy. This was followed by a period of amenorrhea for one year. Later she became pregnant and gave birth to a normal healthy child four years after treatment.

Theory of Irradiation Effects. The manner in which irradiation produces decrease in the fibromyoma is not certain. Some authors believe it is solely due to stopping of the periodic uterine congestion and thus decreasing nutriment to the tumor. The artificial menopause probably plays an important rôle as is evidenced by the fact that fibromyomas frequently undergo involution at the menopause. That this is not the sole effect of irradiation is definitely shown by the above mentioned case in which the irradiation was confined to the tumor, and the menses never ceased. It is also shown by the fact that frequently fibromyomas are seen to be present and to be enlarging after the menopause. Katz[27] reported 6 per cent of the cases seen in the clinic of the University of Vienna to have passed the menopause when they applied for treatment. This corresponds closely to our cases in which 8.2 per cent were in women who had passed the menopause when their symptoms began.

In the foregoing discussion, we have not considered roentgen therapy and radium therapy separately. Each has its advantages; each has accomplished good results, and frequently both are best combined.

Advantages and Technique of Roentgen Therapy. (1) Roentgen rays are almost universally available, but the skill in their therapeutic application is not so universal. (2) Roentgen rays are more useful than radium, especially when the fibroids are large, for they produce a more direct and homogeneous effect on the tumor as well as on the ovaries. (3) Roentgen therapy can be applied usually without interfering seriously with the patient's occupation. (4) It is less expensive, and hospital costs are avoided. (5) The effect is produced more gradually than either by operation or by radium. (6) It eliminates nervous shock as well as any objection to intrauterine applications. (7) It produces no caustic action upon the endometrium.

The technique of the application of the roentgen rays in uterine fibroids has passed through evolutionary changes. Twenty-seven years ago, when we (Pfahler) began to use irradiation, only low voltage roentgen rays were available, and therefore it was necessary to give all treatment through the abdomen and use many portals of entry. Now, since high voltage rays are available, we use 200 kv., 4 ma., 0.5 mm. Cu filter, at a distance of 50 cm., and in the smaller fibroids we make use of three portals, as recommended by Holfelder, one anteriorly and one through each sacro-sciatic notch with the central ray directed through the uterus. If the tumor is very large, more portals must be used and great care must be observed so as not to cross-fire on the subcutaneous tissue and produce a fat necrosis. It is possible to give all the irradiation on one day, but this usually results in serious radiation sickness. We therefore usually treat the patient with 50 per cent doses serially through each of the three fields, until 100 per cent is given through each field. In larger tumors or young people, twice this amount is needed. We avoid,

when possible, giving more than a total of 250 per cent through any abdominal field, because of the danger of fat necrosis, fibrosis, and telangiectasis, and cross-fire effects on the subcutaneous tissue near the surface must be avoided.

Advantages and Technique of Radium Therapy. (1) On account of the frequency of uterine fibroids of small size, often without symptoms, it must be realized that a patient may have a fibroid, and also have carcinoma of the body of the uteras. Therefore, a dilatation and curettement is often necessary for an accurate diagnosis. This curettement is only necessary when there is thought of malignancy. Under such circumstances it is our rule to introduce radium at the same time, and thus eliminate delay, dissemination, and a second operation. Such radium treatment is at least a step in overcoming the patient's disease. (2) As a rule, one can obtain from a competent pathologist a microscopical report within twenty-four hours, then if malignancy is present the radium treatment within the uterus can be prolonged for the maximum toleration effects. (3) A single application of radium in a patient with a small fibroid will usually be sufficient to bring about an amenorrhea, and a cure. This is especially valuable for out-of-town patients. (4) If a polyp or endocervicitis is associated with the fibroid it will be successfully treated by this single procedure. (5) Radium usually causes a prompt cessation of hemorrhage, and produces a fibrosis which eliminates any danger of subsequent hemorrhage. Therefore, radium must not be used when subsequent pregnancy is desired.

Technique of Radium Application. We have long been convinced of the superior value of larger quantities of radium used with high filtration, for in the treatment of uterine fibroid we not only want the effect on the interior of the uterus, but we aim to reach the ovaries and a considerable amount of fibroid tissue, both of which are relatively far from the uterine canal in terms of millimeters. Therefore, one of us (Pfahler)[38] in 1926, developed and described a uterine applicator for insertion into the uterine canal. It was designed to irradiate the entire canal, and therefore is 2½ or 3 inches in length, and will accommodate three 50 mg. capsules. The radium is screened with 1 or 2 mm. of platinum (=2 or 4 mm. lead) and 0.5 mm. of hard rubber or aluminum. It corresponds to the curve of a uterine sound, and when firmly grasped in a special forceps, it can be introduced like a sound. After the dilatation and curettement this is inserted under aseptic precautions and left in place twenty-four or forty-eight hours, depending upon the conditions present. The vagina is well packed both to keep the applicator in place and to displace the bladder and rectum as much as possible.

In the larger size group of fibroids and in malignant disease we almost always use both radium and deep roentgen therapy.

In our series of 297 cases, 152 were treated by roentgen rays alone, 88 were treated by radium and roentgen rays combined, and 13 were treated by radium alone, while 44 cases were examined and either because of strong maternal desire, very large fibromyomas, calcified, degenerated or submucous fibroids, were referred for surgery. The small proportion of cases treated by radium alone in this series is due to the fact that the smaller sizes are commonly referred to the gynecologist, and more commonly the larger size of those suspected of being malignant are referred to the radiologist.

Contraindications to Irradiation.

(1) Very large fibroids which extend to or beyond the umbilicus should not be treated, unless the patients cannot or will not be operated upon. Even in large fibroids the production of amenorrhea by roentgen irradiation helps to overcome anemia and makes a later operation possible. In such cases, the total irradiation over the abdominal wall must be carefully guarded. This opinion is shared by both Burnam and Corscaden.

(2) The association of acute or even chronic inflammatory disease in the pel-

vis is considered a contraindication to the insertion of radium. If, however, an operation is contraindicated, roentgen irradiation can be used with beneficial effect both upon the fibroid and the inflammatory process. Polak[39] and Gál[17] have employed roentgen irradiation in the management of acute inflammatory disease. In fact, since Guthmann and Bott[20], in 1926, published their thesis suggesting temporary sterilization in the treatment of adnexitis and parametritis the literature has been abundant upon the value of the roentgen rays in pelvic inflammatory disease, reports being given by such men as Holzknecht,[24] Heidenhain and Fried,[23] Guthmann and Bott,[20] Polak,[39] Wintz,[50] Wagner,[48] Theodor,[46] Guthmann,[21] Seisser,[42] Cassidy and Stumpf,[7] Soiland, Costolow and Meland,[43] Gilbert and Eghiayan,[19] Kamniker and Simon[26] Siedentopf,[41] Flaskamp,[15] and others. The exacerbations of the inflammatory pelvic disease which occur at the menstrual periods are eliminated by the temporary amenorrhea. One also obtains a direct effect upon the inflammatory tissue.

(3) Malignant degeneration does not occur as a result of the irradiation and this fear should not be an argument against irradiation. Statistics have shown that the incidence of sarcoma or carcinoma in uteri treated by irradiation is less than the general incidence of the conditions for the same age period in women generally. Therefore, it would be illogical to state that all women should have a hysterectomy upon reaching the age of forty. Incidence of malignancy of the uterus is only slightly greater than the operative mortality of the best surgeons performing hysterectomy, and the incidence of malignancy of the uterus treated by irradiation is less than the operative mortality of unselected patients upon whom hysterectomy is performed, and therefore surgical removal simply because of the possibility of subsequent malignant degeneration is injudicious.

Macfarlane,[31] in a review of the literature up to 1930, was able to find only seven articles in which 29 cases of malignant degeneration of the uterus following irradiation were reported. Werner,[49] of Vienna, on the basis of 2,680 patients treated by radium or roentgen rays for myomas or climacteric bleeding, reported an incidence of 0.3 per cent; Vogt,[47] of Tübingen, on the basis of 1,300 similar cases, reported an incidence of 0.4 per cent. Since carcinoma of the uterus occurs in approximately 5 per cent of all gynecological cases and in only 0.3 to 0.4 per cent of irradiated cases, irradiation obviously affords a distinct protection against its development. According to the mortality statistics of the United States Department of Commerce, the general incidence of carcinoma of the uterus is 2.4 per cent. Kelly and Cullen[29] report an incidence of 3 per cent of carcinoma with fibromyoma. It must be concluded that fibromyoma is not predisposed to carcinoma and that irradiation is a prophylaxis against subsequent development of carcinoma.

Masson,[32] in reporting from the Mayo Clinic, states that sarcoma is found in about 2 per cent of the cases of fibromyoma removed surgically. Meaker[33] states that the average of reports indicates that about 1 per cent of these cases show histologic malignancy, many of which, however, are clinically benign. Only when the malignancy rises above a certain threshold does the growth burst its bounds and become an actual menace to life. Myosarcoma of the uterus is an exceedingly uncommon cause of death. Ewing states that in twenty years he has encountered 3 cases of malignant uterine myomas with general metastases. The infrequency with which sarcomatous degeneration is found following radiation therapy of uterine myomas must lead one to conclude that the dose used to treat the myoma is sufficient either to destroy or inhibit malignant tendency.

To recapitulate, surgery and irradiation each enjoys certain advantages.

Advantages of Surgery:

(1) Complete and immediate removal.

(2) Tissue available for microscopic examination.

(3) Fibroids undergoing malignant degeneration are removed, as shown above. This is a rather doubtful advantage.

(4) Complications encountered are removed, as ovarian cyst, ovarian carcinoma and adnexal disease, probably the greatest advantage of surgery.

Disadvantages of Surgery:

(1) Operative mortality. Clark and Block[9] report an operative mortality of less than 1 per cent in uncomplicated cases, but many of the cases are complicated, so that the actual mortality in unselected cases is considerably higher. Strassmann[45] reports an operative mortality of 3.6 per cent of 529 cases in the Berlin Clinic. Jinkins,[25] in analyzing 686 surgical cases, reported a mortality of 2.8 per cent. Wood[51] reports an operative mortality of 1.5 per cent in 1,000 myomas operated upon at St. Luke's Hospital in New York.

(2) Economic loss to patient. Incapacitation for a period of one to two months in cases having an uneventful postoperative convalescence.

(3) Inadvisability in constitutional diseases such as pulmonary tuberculosis, cardiorenal disease, diabetes, profound anemia, etc.

Advantages of Irradiation:

(1) Absence of shock and inconvenience of operation.

(2) Absence of immediate mortality in roentgen therapy and a mortality of only 0.1 per cent with radium.

(3) High percentage of relief.

(4) Earlier treatment due to absence of apprehension in patient.

(5) Hospitalization unnecessary with roentgen irradiation.

Disadvantages of Irradiation:

(1) Less effectual in pedunculated, subserous or submucous myomas.

(2) Necrotic, degenerating myomas best treated surgically.

(3) Acute inflammations are not always favorably influenced by irradiation. Chronic inflammation frequently is improved by irradiation.

(4) Malignancy cannot always be excluded. The irradiation employed in the treatment of uterine fibroids is less intense than that used in the treatment of uterine malignancy. The amount of irradiation employed, therefore, would usually be inadequate in the presence of malignant degeneration. By doing a dilatation and curettement and inserting radium as above, the danger of malignancy can be well controlled.

The record of the cases treated in Dr. Pfahler's private clinic is briefly as follows:

Cases of fibromyoma treated by irradiation	253
Roentgen therapy alone	152
Radium therapy alone	13
Radium and roentgen therapy combined	88

There were 44 cases in which irradiation was not considered the treatment of choice and surgical removal was advised.

Nine of the patients had had previous myomectomies performed with later recurrence of their bleeding. Satisfactory results were obtained in these cases by irradiation.

Of the 253 patients treated by us, 18, or 7.1 per cent, were subsequently operated upon due to a persistence of symptoms. Ovarian cysts were probably the most frequent cause of a persistence of the symptoms. Large cystic, degenerating, or calcified fibroids were also found to be causes of a persistence of the symptoms.

Of the 253 patients, 12, or 4.7 per cent, have died from genital malignancy. Nine of these died from carcinoma of the uterus; one from sarcoma of the uterus and 2 from carcinoma of the ovary. Of the 9 patients who died from carcinoma of the uterus 6 died within two years and the growths were probably malignant from the start, an error in diagnosis having been made. Three, or 1.1 per cent, developed carcinoma of the uterus in later years; 2 of these latter 3 cases were treated many years ago by roentgen therapy alone and one was treated by combined radium and roentgen therapy.

Thus, 7.1 per cent of the patients were subsequently operated upon, and 4.7 per

cent of the patients later died of genital malignancy. Very gratifying results were obtained in 88.2 per cent of the cases of fibromyoma treated by irradiation. There were 19, or 7.5 per cent, of the patients in our series who had passed the menopause before coming under our observation. Of these, one died two years later from carcinoma of the ovary, two died one and two years later from carcinomatosis of the abdomen, and one died from kidney disease eight months after treatment was begun. We believe that these 2 cases were incorrectly diagnosed, and had insufficient treatment. A satisfactory result was obtained in 79 per cent of these post-menopausal fibroid cases in which the average age was fifty-five years, the oldest patients being seventy-one and seventy-six years of age.

We have not made a statistical study of the number of menstrual periods which followed irradiation. This depends upon several factors, namely, the age of the patient, the period of the menstrual cycle in which the treatment is given and the dosage and type of irradiation employed, whether radium or roentgen rays. It is our observation that the younger the patient, the more treatment may be instituted at any time but by beginning treatment immediately following the menstrual flow, there is less likelihood of there being a severe subsequent period. Radium usually produces a more prompt hemostasis than roentgen therapy.

It is often difficult to estimate the size of a fibromyoma accurately and to determine the decrease in size following irradiation. A series of 162 cases were selected, however, in which a satisfactory estimate as to the size could be made and it was found that the average tumor was 50 per cent of its original size in three months, 30 per cent in six months and the majority of the tumors were not palpable in a year. There is considerable variation according to the density of the tumor, the softer tumors disappearing more quickly than the firm, dense lesions. Some of the larger tumors were palpable for a long period. Lesions containing calcareous deposits do not show appreciable diminution in size.

Libido or sexual desire was found to be influenced slightly if at all by irradiation. At the time of treatment, particularly following introduction of radium, sexual relations were suspended due to vaginismus, leucorrhea, etc., but after several months when these symptoms have subsided sexual relations can be resumed. A group of 14 cases were analyzed in which it was possible to discuss this subject frankly without too much embarrassment to the patient (it must be remembered that this report of 253 cases includes private cases only). Of these 14 cases, 9 reported no change in their sexual desire; 3 reported decreased desire and 2 reported increased desire. Hanks[22] reporting from the Mayo Clinic, calls attention to the fact that following roentgen castration, intercourse has been enjoyed to its fullest. There is a knowledge that all her organs are present. Such is not the case following hysterectomy. Gilbert and Eghiayan,[19] by a comprehensive review of their own cases and those reported in the literature, conclude that libido is less influenced in those cases in which the menopause has been induced by irradiation than those in which it has been induced surgically. Bride[5] reports an alteration of the sexual desire in 39 per cent of his postoperative cases.

SUMMARY AND CONCLUSIONS

(1) A review of about 15,000 cases of uterine fibroid collected from the literature, including our own cases, shows a curative value of irradiation treatment of about 95 per cent. By "cure" is meant relief from hemorrhage and a disappearance or reduction of the tumor to a size that does not give symptoms.

(2) Irradiation is the method of choice in practically all cases in which the tumor does not extend more than midway between symphysis and umbilicus.

(3) In small fibroids, radium treatment is usually sufficient, but in the same group

of cases, deep roentgen therapy is also successful. The treatment can now be given without any serious risk.

(4) In small fibroids, occurring after forty years of age, and especially if there is any intermenstrual bleeding it is our present practice to do a dilatation and curettement and at the same time insert the special applicator containing 150 milligrams of radium for twenty-four hours and if the lesion is found to be malignant, the applicator is left for forty-eight hours.

(5) High voltage roentgen rays are especially useful in the treatment of the larger fibroids due to the more direct and homogeneous effect on the fibroid itself.

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SOME PROBLEMS IN RADIATION THERAPY OF CARCINOMA OF THE CERVIX*

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CANCER of the cervix, we fully realize, has been largely transferred to the realm of radiation therapy. The disease is seldom recognized sufficiently early to permit of satisfactory surgical removal and, moreover, cervical cancer seems to be rather radiosensitive and responds reasonably well to irradiation so that even the early cases can be treated by this method to advantage and with less risk than by surgery.

The radiation therapist has important problems to consider in the treatment of these cases. There are many factors which play a part, small or large, in determining either the immediate response to treatment or the ultimate end-result.

Among these are the stage of disease at which the diagnosis is made, the presence of infection, toxemia, anemia, diabetes, obesity, etc.; the danger of late bladder and rectal complications from damage to the normal structures by the rays, leading to bladder ulcers, vesical hemorrhage, rectal ulcers, stenosis of bowel and intestinal obstruction. Pyometra before or after irradiation is also a problem. Rectal and vesical fistulae must likewise be considered. These and other conditions, immediate or remote, confront us in every case we treat.

In a general way, when the gross lesion seems limited to the cervix we are justified in assuming that the prognosis is fair for obtaining at least a five-year cure with irradiation. This we realize is only a crude method of determining the actual extent of the disease but is the best we can do with our present methods of examination and diagnosis.

In a recent study of 1,574 cases of cancer of the cervix under our observation at the Memorial Hospital we found that 12.5 per cent were early cases in which the growth appeared to be limited to the cervix. If this diagnosis were correct we should have had no difficulty in curing every one of these cases by either cauterization, hysterectomy or irradiation. Unfortunately, however, we do not obtain 100 per cent cures in the early group by any of these plans of treatment. In the final analysis, we must realize it is not the cervical involvement but the disease that has already extended beyond the cervix into other parts of the pelvis before treatment is established that will determine the final outcome of the case.

It is evident then that even these apparently early cases are not as favorable as they seem to be, as the cancer cells have already begun to spread to other parts of the pelvis and this in brief is why we do not depend upon cauterization or hysterectomy for the cure of these cases, but resort to irradiation which not only attacks the cervical lesion but also reaches the disease in all parts of the pelvis. However, even irradiation fails to give 100 per cent cures in the early group and this you may well understand is a great disappointment to us as our five-year salvage in this group was only 55 per cent.

It is important to realize that we rarely fail to cure the cervical lesion in the favorable cases; as a matter of fact, it will have completely disappeared in four to six weeks in nearly every instance, and the disease will seldom recur in or about the cervix. Within a year or two after treatment, however, some of these apparently cured early cases will begin to suffer from pelvic and leg pain and we know, too well, that this is due to metastatic cancer in the retroperitoneal lymph glands, cancer which has continued to grow in spite of our treatment and, when pain appears, is beyond our control.

If the cervical lesion fails to disappear in

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four to six weeks we then resort to interstitial irradiation usually by means of gold filtered radon seeds. If the response to this treatment is not satisfactory and at the end of another month or six weeks it would appear that there is still a bulky cervix due to the persistence of cancer, it is evident that we are dealing either with a radioresistant lesion or with a patient in whom the local tissue reactions to irradiation are unsatisfactory. It is my opinion that further irradiation in such a case will lead to disaster by causing extensive necrosis and sloughing of tissues, whereas a simple vaginal or abdominal hysterectomy at this stage may permit complete healing of the vaginal vault and while the patient lives she will be free from foul vaginal discharge, hemorrhage and fistulae but of course will not be cured of the cancer.

Naturally such a decision as this requires the closest cooperation between the radiation therapist and the surgeon for one must, on the one hand, be sure that adequate irradiation has been used and, on the other, if operation is to be done it should not be delayed too long.

Our greatest problem, it seems to me, is to find a way to sterilize or destroy all the vagrant cancer cells or metastases when we take care of the primary lesion.

I believe at the present time external irradiation with roentgen rays or with strong radium packs offers the most encouragement. But the task is difficult and not easily surmounted.

Glandular metastases do not seem to be as susceptible to irradiation as the primary lesion nor are they as accessible to treatment. To reach them as well as the cancer cells scattered throughout the pelvic lymphatics the rays have to pass through the skin, abdominal wall, intestines and bladder. These structures are all more or less damaged, we know, by the rays and the limit of our radiation dose is the tolerance of these normal structures to radiation. This tolerance is not always sufficient to permit us with our present methods to get enough effective radiation into the cancer-bearing tissues in the parametria and in the retroperitoneal lymphatics along the spine to destroy the cancer cells.

However, it is quite certain that we cannot be content with only 55 to 60 per cent five-year cures in our early cases. The alternative if irradiation fails, it seems to me, may have to be a resort to surgical interference six or eight weeks after the full irradiation procedure as now carried out has been finished in the early cases. Whether this would take the form of opening the parametria for the purpose of placing radium applications therein, a procedure which I do not favor, or would be for the purpose of surgical removal of the parametria and the uterus will no doubt depend largely upon the ability and the facilities available to the individual specialist. Frankly, I personally feel that we must earnestly strive to improve our statistics for five-year cures in the early group. Since we do not need more radiation in the cervix, for we know the primary growth is adequately treated by our present plan, we must concentrate on improved methods of external irradiation to take care of the metastatic foci elsewhere in the pelvis.

At the present time, the average percentage of five-year cures for all cases of cervical cancer treated by irradiation regardless of the clinical stage of disease present when the patient is first seen is 20 to 22 per cent.

It is interesting and it would seem important to note the improvement in Regaud's statistics at the Radium Institute in Paris following a change in their therapeutic procedure.

In 1924 they increased the dosage of external irradiation with the roentgen ray and coincident with that the total salvage of all cervix cases treated in the clinic rose from 24 per cent, their previous average, to 35 per cent, in 1925 to 32 per cent and in 1926 to 35 per cent. This is about 10 to 12 per cent better than all other reported statistics and is attributed largely to the present plan of external irradiation followed by them. This, I understand, con-

sists of about 100 hours' treatment given two hours in the morning and two hours in the afternoon, daily, at 90 cm., with a 200 kv. machine.

It is agreed that at least 75 per cent of all cases of cervical cancer are in an advanced stage of disease when first seen. In our experience this means invasion and destruction of normal tissues with cancer, considerable enlargement of cervical structures and bulkiness of parametria, interference with lymphatic drainage, ulceration, sometimes crater formation, and always infection. So much for the local condition; the patients themselves, while often obese are nevertheless suffering moderately or severely from toxic absorption, anemia, and pain.

The greater our experience becomes in the treatment of these cases with radiation the more we are convinced that the patient's best interests are not served by applying radium at once to the advanced cervical lesion.

We believe that far better results can be obtained by first preparing the field for the application of radium. For this purpose warm astringent, antiseptic vaginal douches (potassium permanganate) are used several times daily. At the same time the high voltage pelvic roentgen-ray cycle is given, if possible in four exposures, one exposure every second day, if the patient's condition will permit, otherwise it may be desirable to give but 50 per cent of a skin erythema dose at each exposure and to double the number of treatments.

In the meantime, the patient's general condition is also taken care of by medical measures, including blood transfusion if necessary. Within two weeks one will usually find a decided improvement in the whole situation, the local lesion will be smaller, cleaner, more firm and the surrounding tissues will be in much better shape to withstand radium applications for there will be decidedly less surface infection. Radium may now be used to advantage and with less risk of complications.

We are convinced that the use of interstitial irradiation by means of needles or seeds in these ulcerated and infected cases without preliminary treatment as outlined is fraught with great risk, as the necrosis which results from a combination of irradiation and infection is almost uncontrollable, and leads to extensive sloughing of tissues often with formation of fistulae, severe hemorrhages and death. For these reasons we have omitted interstitial irradiation from our primary treatment of all advanced cervix cases for the past three years. Nor do we use interstitial irradiation in the primary treatment of the early cases as we believe it increases the chance of metastases.

Our attention is being more and more drawn to bladder and rectal complications observed as sequelae of radiation therapy for uterine lesions and more especially following irradiation for carcinoma of the cervix. We all recognize the mild bladder and rectal symptoms which occur coincident with or immediately after completion of the treatment and subside in ten to fourteen days but we are not so well acquainted with the late bladder ulcers which occur a year or more after treatment and at a time when the patient may otherwise appear to be quite well and in fact may be entirely free of cancer.

The chief symptoms are polyuria, dysuria and vesical bleeding and as cystoscopic examination reveals a lesion, usually ulcer, in the bladder base the natural tendency is to assume the presence of metastatic cancer. Such a diagnosis must be confirmed by biopsy before resorting to radiation therapy, since further irradiation to these post-irradiation ulcers would be extremely unfortunate, would not only aggravate and enlarge the lesion but might be disastrous and result in death of the patient from hemorrhage. In a recent report from the urological division of the Memorial Hospital by Dr. A. L. Dean, Jr., there is a very full discussion of this bladder complication. He estimates that it occurs in about 2 per cent of all patients ir-

radiated, whether for benign or malignant lesions. It is interesting and important to know that the ulcers usually may be expected to respond to persistent treatment in the form of bladder irrigations, instillation of mild astringents and rest and, when cured, do not recur.

The late intestinal lesions are not so common but consist of areas of localized ulceration in the small and large intestine often associated with rather severe blood loss from constant leakage of small quantities of blood so that the patient becomes profoundly anemic and requires blood transfusion. Sometimes the irradiation effect is shown by an intense inflammation involving all the walls of the upper rectum or lower sigmoid for a distance of several inches so that the bowel in the affected area is rigid, infiltrated, swollen, covered by fibrinoplastic exudate and resembles an acutely inflamed appendix. Such a lesion, if it subsides without perforation, tends to result in stenosis of the intestinal lumen and obstruction at a later date. Intestinal complications such as those described usually lead to operation for their relief.

In stressing these various complications it is with the desire to draw attention to the fact that we are handicapped by the limit of tolerance of the normal structures to irradiation in our effort to increase the radiation dose reaching the center of the pelvis. Nevertheless I have shown that it is necessary to increase the radiation effect throughout the parametria if we are to increase the percentage of five-year cures in our favorable cases. It is absolutely essential that we find a way to do this.

The improved statistics published from Regaud's clinic in Paris indicating, as they do, the value of a better plan of external irradiation of the pelvis, and, also the experience in the oral clinic at the Memorial Hospital with a new plan of external irradiation which seems to be giving better results in dealing with metastatic lesions in the cervical glands, it seems to me, justify us in believing that we are on the right road and that combined internal and external radiation therapy properly carried out still offers the best chance of cure to the patient suffering from cancer of the uterine cervix.

DIRECT ROENTGEN IRRADIATION OF INTRA-CAVITARY NEOPLASMS

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THE prime requisites in the irradiation of malignancy in general can be briefly summed up as the following: the application of a lethal tissue dose to the carcinoma cells, with a homogeneous distribution of radiation in the neoplasm, and the further maintenance of this maximum or optimum tumor dose with a minimum skin and uninvolved viscera dose.

Hueper and Schmitz,[3] in their discussion of pelvic carcinomata, have empirically set the lethal tissue dose, for highly immature carcinomata with a predominance of round and epithelial cells or adenocarcinoma, and solid adenocarcinoma, at approximately 2 to 2.5 S.E.D. For the more highly mature carcinomata with spinous epithelial cells or adenoma malignum, and everting papillary adenocarcinoma, the lethal tissue dose has been placed from 4 to 5 S.E.D.

Martin and Quimby,[4] in their report of 10 cases of intraoral malignant neoplasms of various types, which were successfully treated by radiotherapy, found the lethal tissue dose for squamous cell carcinomata to be about 10 S.E.D., and for the transitional cell carcinomata, in the proximity of 2.5 S.E.D.

Thus it is seen that, paradoxically, radiosensitivity increases with the higher grades of malignancy, and conversely.

This marked variation in cellular structure of epidermoid carcinomata led to Broders' classification,[1] in which the tumor is graded into four groups according to the degree of differentiation of the cells. However, in all histopathological classifications of radiosensitivity there is the transient and variable histological neoplastic structure in different portions of the same tumor to consider, and it often happens, that, at a later microscopic examination of the new growth, an entirely different picture is disclosed in reference to the differentiation of the cells.

The factors determining radioresistance of a tumor are numerous; and although they are attributable in the main to the structural components of the neoplasm, there are many other concomitant complicating conditions, which arise in the course of the tumor growth, that have a great and marked influence upon the efficacy of radiotherapy. These have been most thoroughly studied and grouped by Ewing[2] into the following contributory factors: (1) Resistance due to the adult character of the stroma, viz., osteogenic sarcoma; (2) the adult character of the epithelial cells and the substantial blood supply render adenomata and papillomata radioresistant, viz., adenomata of breast and thyroid, papillomata of skin and mucous membranes, and of the larynx; (*note:* there is one marked and common exception to this generalization, the fibromyoma uteri is relatively radiosensitive); (3) carcinomata are resistant in inverse proportion to the amount and degree of anaplasia, and in direct proportion to the amount of desmoplastic reaction which they excite, viz., adenoma malignum and alveolar carcinomata; (4) in mixed tumors in which one element is radiosensitive and the other is radioresistant, the malignant portion may be sterilized and yet the tumor does not diminish in size; this obviously creates a false impression of radioresistance, viz., mixed embryonal and adult tumors of testis, and teratomata; (5) the nature of the tumor bed has a great influence on the response to irradiation; both favoring and in other instances retarding the response to treatment, viz., the high resistance of malignant tumors involving and invading cartilage, bone, and adipose tissue; (6) infected tu-

mors, strangely, do not react well to treatment; (7) acquired resistance due to repeated treatment with inadequate dosage. This is well illustrated in cases of long and insufficiently irradiated tumors which recur in dense cicatricial tissue. Here, the tumor cells, due to their enveloping protection of fibrous tissue and leucocytic infiltration, may have an inherent resistance sufficient to withstand exceedingly large doses of radiation which approach a caustic type, even injuring the stroma and normal cells, while the tumor cells survive. And, strangely, at a later date, these formerly resistant and quiescent tumor cells may suddenly exhibit very active growth with widespread metastasis. This phenomenon is sufficient reason for the delivering of a lethal tissue as speedily as is practically possible, especially when the total dosage required is relatively high. Regaud, in 1914, was one of the first to discover this phenomenon, and has been emphatic in warning of the dangers of fractional dosage over extended periods of time. This diminution of radiosensitivity occurring in repeatedly inadequately irradiated tumors has long been known and is attested by the experience of everyone who has practiced radiotherapy.

Although we do not advocate the "massive dose technique" as was formerly employed and advocated for roentgen irradiation by Krönig and Gauss, and for radium by Healy and Kelly, we are convinced that a lethal tissue dose can only be realized by the combined use of radium therapy, and external and direct roentgen irradiation, where the latter is feasible, and furthermore, that all these agents should be employed in a relatively short period of time.

The success of radiotherapy is dependent upon many factors, and undoubtedly the most important factors are the early recognition and early thorough treatment of the malignancy. The other factors to be considered are as follows: the relative radiosensitivity of the lesion; the location of the neoplasm, especially in regard to its accessibility; the size of the neoplasm; and the depth of the new growth. In addition, we have the viscera to consider in which the neoplasm is progressing or is near, inasmuch as they may be vital organs, the damaging of which by radiotherapy may cause death. The proximity of the neoplasm to bone and

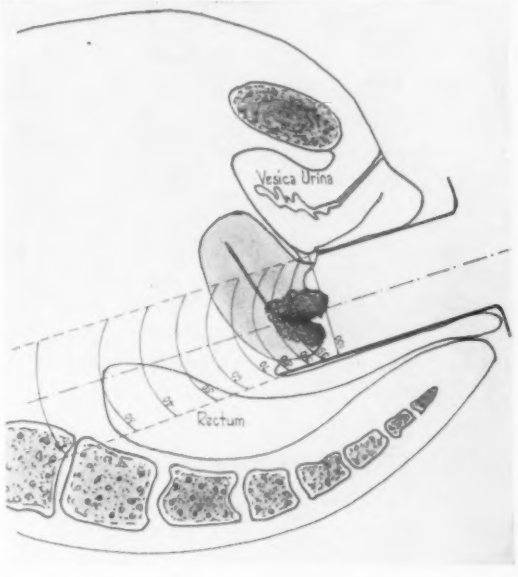

Fig. 1. Median longitudinal section through female pelvis with lead vaginal speculum inserted, exposing carcinoma of the cervix. Isodose curves for 4 cm. diameter field, 200 kv., 0.5 mm. Cu and 2.0 mm. Al filters, 50 cm. skin target distance, are designated in percentages. (Modifications of isodose curves by Weatherwax and Robb.)

cartilage may contraindicate thorough irradiation, as necrosis is prone to occur in these tissues. The physical factors of irradiation to be considered are: the distribution of the source of radiation; the type of radiation, whether radium, radon, or roentgen rays, the filtration determining the wave lengths and in the case of roentgen rays, the kilovoltage additionally varying the penetration; the length of time of application with the proper adjustment of the intervals between exposures. Certainly, one must include in the above, the proper and best apportioning and directing of the radiation, enabling the accruing of the maximum benefit from radiotherapy.

It is the current universal opinion that

the advanced radioresistant carcinomata necessitate the administration of larger quantities of radiation than are at present customarily employed. With the present methods of applying radiation, namely, the cavitary, the interstitial, and the distant methods, the sources of radiation being either radium, radon or roentgen rays or their combination, we are often unable to obtain a lethal tissue dose in the desired area without untoward damage to the uninvolved organs and skin.

Interstitial irradiation is complicated and it is very difficult to obtain an exact and uniform distribution of radiation from these small "point" sources, and the implantation of radium or radon seeds into a new growth and its contiguous tissue is ever fraught with the potential danger of opening lymph and blood vessels, or lowering the local resistance by traumatizing the tissue, thereby creating avenues for metastasis. This, we feel, can be prevented to a great degree by the judicious use of surface irradiation, either by contact radium or, preferably, by direct roentgen irradiation, which we advocate. That there is no difference in lethal effect between long and short wave radiation when employing identical dosages is a moot question. Suffice it to state that this has been experimentally proved by Wood[5] in his direct animal tumor demonstrations.

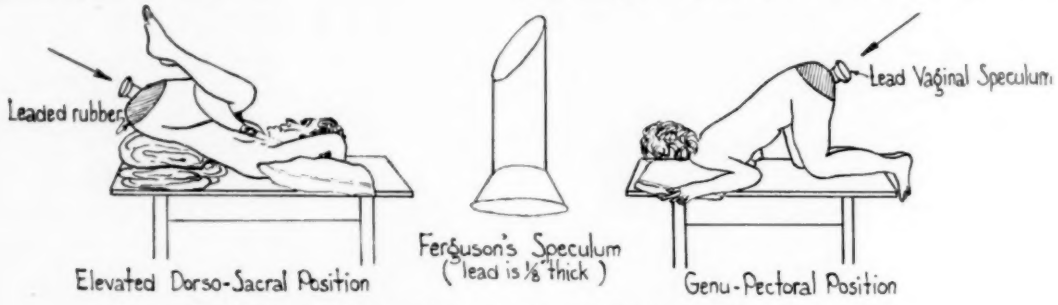

FIG. 2. Positions suitable for direct roentgen irradiation of the cervix uteri.

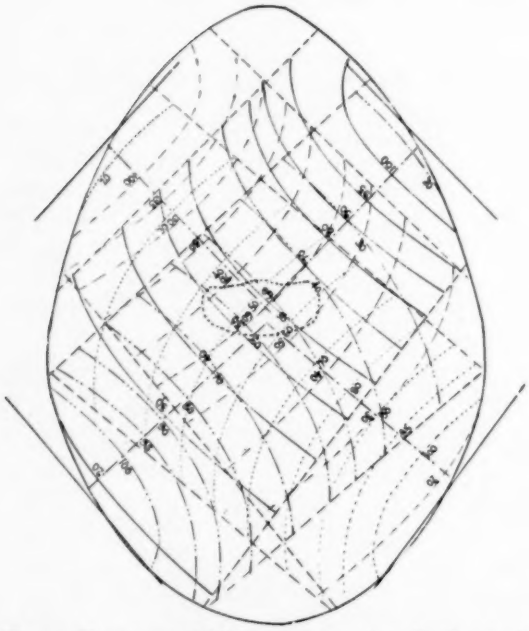

FIG. 3. Four port shielded roentgen irradiation technique, 100 per cent S.E.D. (800 r) applied through each port equals 216 per cent S.E.D. (1,728 r) in tumor. Total skin effect equals 120 per cent S.E.D. (960 r); 216 per cent minus 126 per cent equals 90 per cent S.E.D. (720 r), increased tumor dosage. Note:—Technical factors the same as in the unshielded technique.

Primarily, it was this omnipresent factor of insufficient irradiation of malignancy that stimulated the formulating of the following method of direct roentgen irradiation of the neoplasm, our endeavor being to apply the lacking amount of radiation necessary for the summation of a lethal tissue dose without the concurrent detrimental effects to the skin and uninvolved tissue.

Manifestly, the cavitary neoplasms of the body, which are easily and practically accessible, are most suitable for the application of this method or radiotherapy. These, in the order of ease of accessibility, are the intraoral, cervical, and rectal carcinomata. And furthermore, in these sites, only those lesions which are in a position

for the speculum to guide the rays are amenable to this form of therapy.

In recommending direct roentgen irradiation in intracavitary carcinomata, we cannot supplant the interstitial use of radium, but rather supplement it; and in those cases where palliation unquestionably is the only benefit to be derived, that is, when the primary growth and metastases are much too extensive for any hope of cure, this method is most certainly a less formidable means of accomplishing this, both from the standpoint of the physician and patient. Again, it must be remembered that not all radiologists have access to large amounts of radium and radon, and must treat the patient with the best available methods.

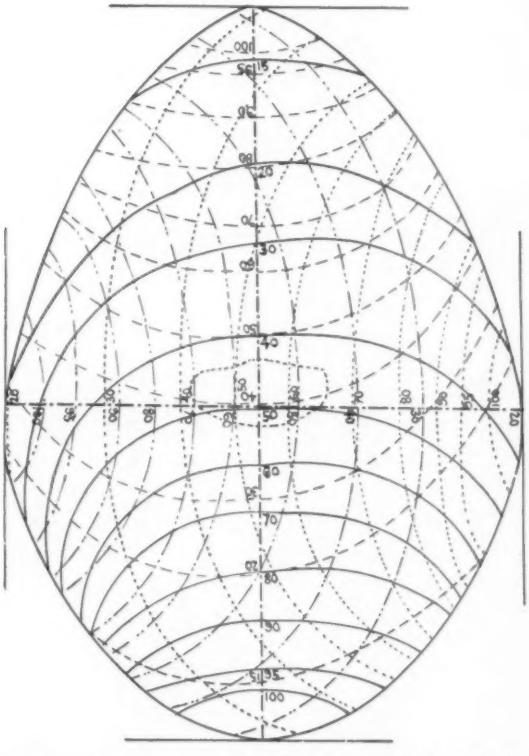

FIG. 4. Four port unshielded roentgen irradiation technique; 100 per cent S.E.D. (800 r) applied through each port equals 200 per cent S.E.D. (1,600 r) in tumor; Total skin effect equals 190 per cent S.E.D. (1,520 r); 120 per cent S.E.D. (960 r) skin tolerance equals 126 per cent S.E.D. (1,008 r) in tumor. Technical factors: 200 kv., 0.5 mm. Cu and 2.0 mm. Al filters, 50 cm. skin target distance; cross section level No. 16 (Eycleshymer and Schoemaker). Average dimensions: anteroposterior 17.5 cm. transverse, 12.5 cm.

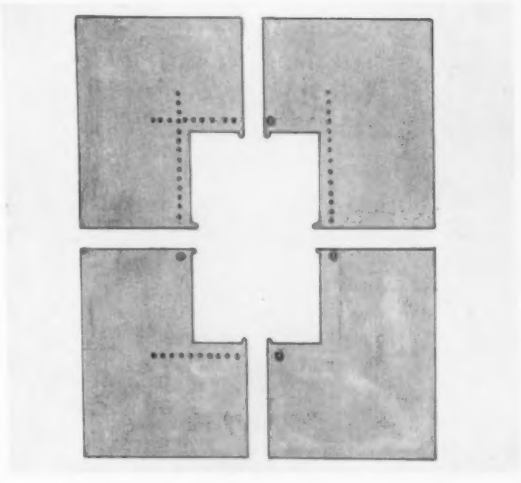

FIG. 5. Adjustable leaded rubber shield. Showing the clasps and projecting tips of leaded rubber for aiding in localization of exact center. By means of the clasps the aperture can be varied to any desired dimensions.

In a number of patients with squamous cell carcinoma of the cervix uteri there is an accompanying atresia of the cervix. In these cases one is often unable to insert radium in the cervical canal, being either unable to locate the canal or after finding it, procuring insufficient dilatation. In these cases especially, it is deemed most advisable to give direct roentgen irradiation to the malignancy. This results in a marked regression of the cervical mass which permits of finding and dilating the cervical canal. It is the opinion of most radiologists that the principal internal radium treatment should not begin until the canal is patent, as the best results are obviously secured only by placing the radium in the entire length of the canal. At times such remarkable regression of the mass is obtained that it is thought sufficient merely to continue with direct and external roentgen irradiation; however, this is not the ideal treatment, but it is of course better than no irradiation if one is unable to procure radium. It is true that external roentgen irradiation often causes a similar regression of the atresia of the cervix, but

much more slowly and less effectively.

In regard to the cervical infection that almost invariably accompanies cervical carcinoma, it is our conviction that it is imperative to control this condition before proceeding with intracervical radium treatment. If this is not done, one may secure an undesirable febrile reaction, and occasionally a severe complication such as acute pelvic cellulitis, suppurative salpingitis, circumscribed phlegmon, generalized peritonitis, and septicemia. This infection can often be entirely cleared up by preceding the uterovaginal radium treatment with antiseptic vaginal douches. During this preliminary sterilization of the infected area, direct or external roentgen irradiation can be employed, the former having the distinct advantage of direct visualization of the cervix at each seance, and thereby the progress of the pathological process is better understood and more intelligently treated. It is undecided whether or not irradiation has a helpful influence upon the infection, but in our experience it has.

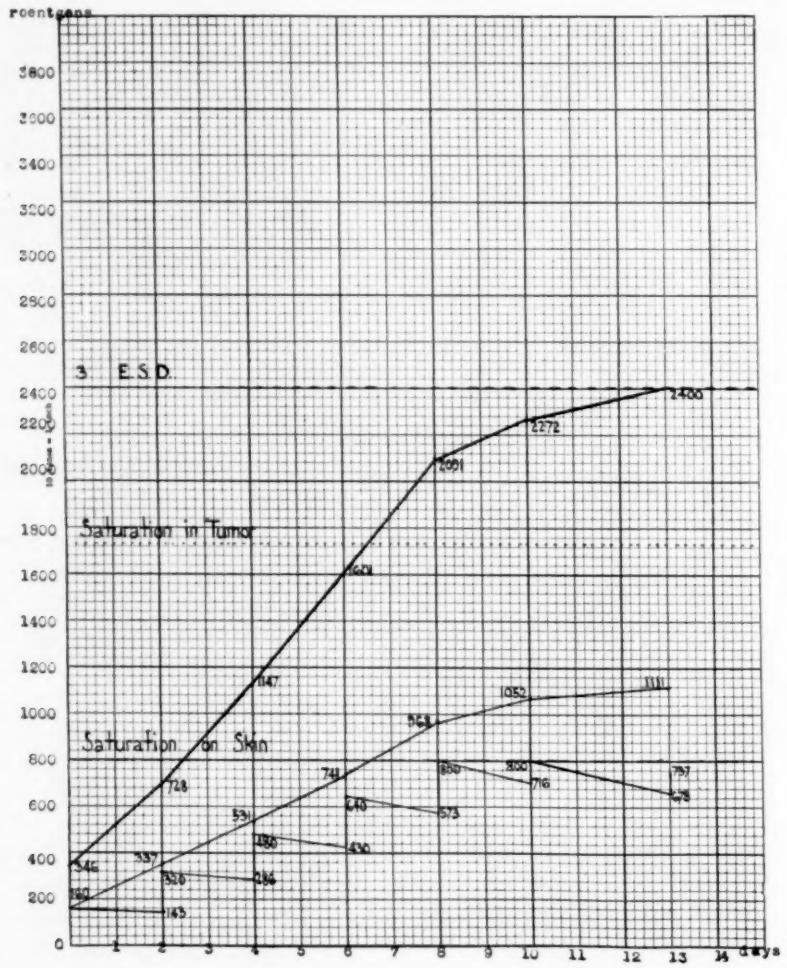

FIG. 6. A typical graphic representation of the Pfahler-Kingery saturation method of irradiation of a case of intraoral carcinoma through four ports of entry, employing the shielded semilateral technique.

There were a few mechanical difficulties to overcome in the perfecting of this method. First, the present vaginal specula were unsuitable for our use inasmuch as there was inadequate protection to the vag-

inal tract during the roentgen exposure. The first specula we devised were lead replicas of Fergusson's glass vaginal specula, constructed of 1/16″ thickness of lead and made in the following size diameters, 20, 30, 40, and 50 cm. (see Fig. 2). The specula are held in position by adhesive tape. Further precautions against possible skin irritation from misdirected roentgen radiation are taken by placing the speculum through an aperture in a leaded rubber sheet which is placed about the introitus.

Subsequently, we improved upon this procedure by employing an ordinary self-retaining Graves' vaginal speculum, and after positioning the speculum, and exposing the cervical area, a cylinder or lead speculum was inserted through this, which afforded the protection against irradiation of the vaginal walls. However, this had one serious drawback, namely, it permitted of much less surface area of the cervix for exposure to radiation. At the present time, we are employing our own modification of McLaughlin's vaginal speculum, which was originally designed for the purpose of cauterizing the cervix. This improved speculum, we believe, embodies most of the advantages and desiderata necessary for this type of irradiation. It is self-retaining, gives absolute protection to the vaginal tract and introitus, it has a variable size aperture and can be procured in the three standard sizes, namely, small, medium, and large, and in addition permits of a larger field for irradiation than any other type speculum. We are contemplating the improving of this speculum by the addition of two lateral blades which operate in the same manner as the present two blades; this permits of a much larger lateral field for irradiation. This is of special importance in view of the fact that there is an early extension of the carcinomatous process into the broad ligaments of the uterus. Objectionable static discharge from the speculum is easily overcome by means of a wire which is grounded, it being fastened

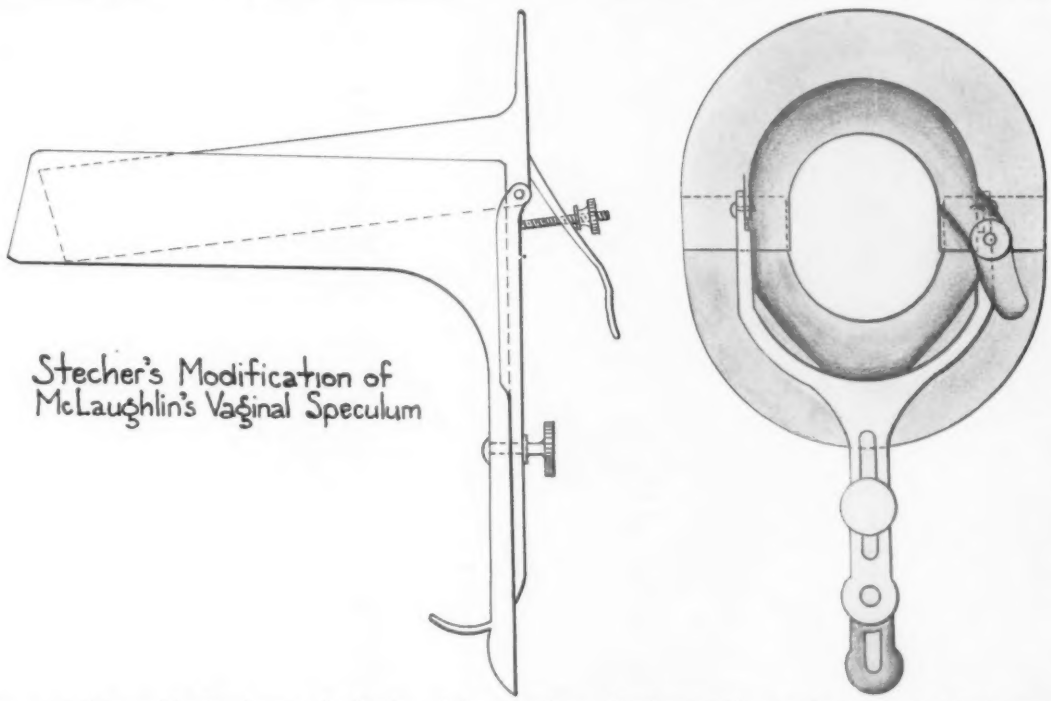

Fig. 7. As is graphically shown, the blades of the speculum afford protection to the vaginal walls inasmuch as they are constructed of lead and overlap. The broad apron-like lead protective rim is to be noted. An ordinary speculum can be modified by riveting 1/16″ lead upon the blades and shaping as is illustrated.

upon the speculum and then fastened to a cold water pipe or other suitable "ground" such as the table which is already grounded (Fig. 7).

In the direct roentgen irradiation of carcinoma of the cervix uteri, we found two satisfactory positions of the patient for the introduction of the speculum, concomitant with accessibility and safety to the patient from accidental high voltage shock. The dorsosacral elevated position and the genupectoral position are both adaptable. The former has the advantage of gravitating the uterus dorsally, which tends to position the uterus and cervix more in a direct line with the beam of radiation. On the other hand, the genupectoral position has the advantage of being relatively safer, especially if one does not have shock proof deep roentgen therapy equipment (see Fig. 2). With any reasonable care this factor of high tension shock is nil; but we have purposely overemphasized it.

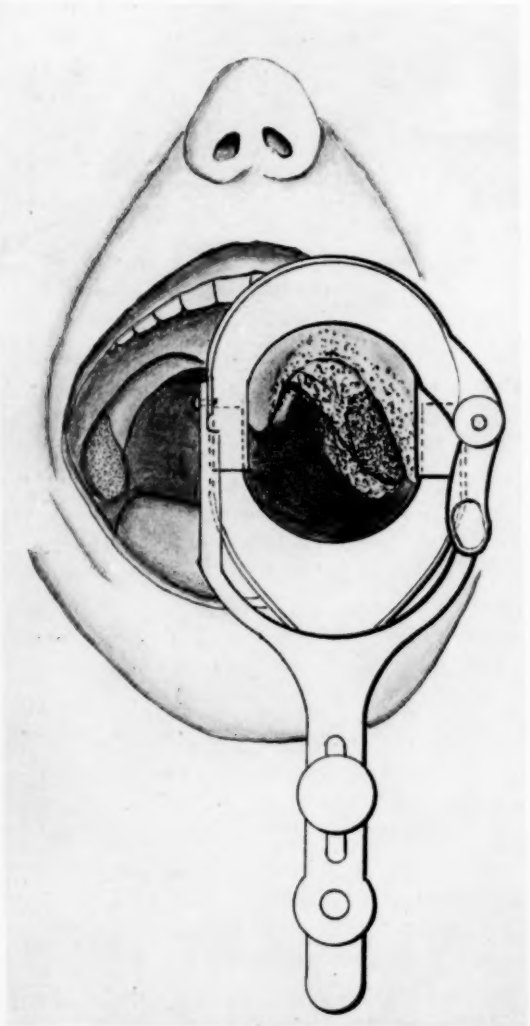

FIG. 8. Showing lead speculum in position for direct roentgen irradiation of carcinoma of the tonsil. Note that in this illustration the protective leaded sheet rubber is not shown for purposes of clarity.

As yet we have not definitely reached a conclusion as to the most favorable technique to employ relative to the quantity and quality of the radiation delivered to the tumor. At the present time we have adapted the Pfahler-Kingery fractional saturation technique to this procedure, employing the physical factors stated in Figure 1. We are guided primarily by the tolerance of the patient to the radiation, and by the patient's reaction as we progress with the treatment. It is questionable whether it is advantageous to deliver a massive dose by this method, at one seance, as is done in roentgen therapy of basal cell epithelioma in dermatological practice.

In addition to the above roentgen irradiation, all cases receive external roentgen irradiation, the technique of which follows. The relative tumor and skin dosages are computed by means of isodose curves, after carefully charting and measuring the patient. Then the tumor dosage is converted into a 100 per cent value, using the skin saturation as a standard. The S.E.D. value with the following physical factors is 800 r. This, in the average case, permits of a relatively lower skin dosage to be employed for the delivering of this radiation to the tumor, when the standard four field technique is employed. The physical factors are as follows: 200 kv.; 0.5 mm. Cu and 2.0 mm. Al filters; 50 cm. skin target distance; 30 ma., water-cooled tube. On alternate days 20 per cent S.E.D. (160 r) are applied through all four ports; included in this is the loss of radiation in roentgens between each seance. This is continued until

the predetermined skin saturation has been reached. Then the loss of radiation in roentgens between each treatment, of three-day intervals, is replaced, until the total tumor dosage is equal to 2 S.E.D. (1,600 r). This constitutes one series. After a lapse of six to eight weeks a second series is commenced; and a third series after twelve to sixteen weeks' intermission. The ultimate aim in the saturation technique is to saturate the tumor as quickly as is possible, without objectionable untoward effects, and to further maintain this optimum dose for two to three weeks until the desired radiation, namely, 2 S.E.D. (1,600 r), has been delivered into the tumor.

In the direct roentgen irradiation of intraoral carcinoma, we have found the vaginal speculum described here to be perfectly adaptable for this region. Inasmuch as the lower blade of the speculum acts admirably as a tongue depressor and the handle is quite suitable for the holding of the speculum in place by the patient, we have continued to use this speculum in our work. We are considering the construction of a tongue depressor with a handle permitting of easy grasp, with a removable lead speculum to be attached to the blade. In most cases we have found it unnecessary to resort to the use of a mouth gag. To prevent gagging we recommend thorough anesthesia with 4 per cent cocaine solution, applied to the posterior aspect of the tongue and to the lesion. In nervous uncooperative patients, further psychological means such as instructing the patient to breathe slowly and deeply through the mouth, are often most helpful. It has been our experience that it is preferable to precede the direct roentgen irradiation with a course of external roentgen irradiation. This procedure tends to make the intraoral mucosa quite insensitive and permits of ease of retention of the speculum with a minimum of nausea.

In regard to the position of the patient during a treatment, we have found it more satisfactory to have the patient in the sitting posture, with the head held firmly in position by means of an adjustable head rest and an immobilizing band. We instruct the patient to signal the operator with his free hand if the nausea becomes intolerable. However, the position of dorsal decubitus is also satisfactory. This has the uncertainty of the tongue falling back and obscuring the field of radiation.

Since rapidity and expediency are virtual necessities in intraoral direct roentgen irradiation of neoplasms, it has been our practice to irradiate the lesion as long as it is feasible. We cease irradiating when the patient moves or is about to move out of position, due to gagging. We reinsert the speculum after the patient has regained confidence, and continue the treatment in this manner until the total amount of radiation desired has been delivered (see Fig. 8). At present we are employing the following physical factors: 200 kv.; 0.5 mm. Cu and 2.0 mm. Al as filters; 50 cm. skin target distance; 30 ma., water-cooled tube. With these constants we are able to obtain 1 S.E.D. (800 r), in twelve minutes. At the present time we are experimenting with less filtration and a shorter skin target distance, which will greatly speed up the treatment.

Routinely, external roentgen irradiation precedes intraoral radiotherapy, and is delivered through four parts, in all intraoral carcinomata with or without cervical lymph node involvement. It is our conviction, both from theoretical considerations and from practical experience, that the shielded method of irradiation is far superior to the unshielded technique. As is graphically depicted in Figures 3 and 4, which represent the average case, we can increase the tumor dosage approximately 16 per cent (128 r), merely by the use of the semilateral cross-firing positions, rather than employing the conventional anteroposterior and lateral fields. Not only is there this increased tumor dosage, but, in addition, the patient need not be moved into four different positions during the treatment. The patient remains in the supine position during the irradiation of the two anterior semilateral fields, moving the

tube to the desired angle. The same is done with the patient in the prone position. If one attempts to irradiate the direct lateral field by having the patient rotate the neck through a 90° angle, there is a considerable degree of overlapping of radiation. This is due to the fact that the skin of the neck does not move synchronously with the deeper structures which are being irradiated.

By means of the isodose curves, one can compute with a fair degree of exactness, the amount of radiation delivered into the tumor, together with the total cumulative skin radiation, which includes the direct, transmitted and overlapping radiation. In this manner we are able to compare the shielded with the unshielded technique of irradiation of intraoral malignancy through four ports.

In the unshielded anteroposterior and lateral technique, a 200 per cent S.E.D. (1,600 r), is delivered into the tumor, when applying a 100 per cent S.E.D. (800 r) through each of four ports. Experience has taught us that the skin of the face and neck region can easily tolerate a 120 per cent S.E.D. (960 r), when employing the following physical constants: 200 kv.; 50 cm. skin target distance; filters of 0.5 mm. Cu and 2.0 mm. Al; the skin erythema dose being equal to 800 r, exclusive of back-scattering. Reducing the tumor dosage in direct proportion to the skin tolerance of this region of the body, the amount of radiation delivered into the tumor is equal to 126 per cent S.E.D. (1,008 r), when the total cumulative skin dosage is fixed at 120 per cent S.E.D. (960 r).

In direct contrast, 216 per cent S.E.D. (1,728 r), is delivered into the tumor when applying a 100 per cent S.E.D. (800 r) through each of four ports, when employing the shielded semilateral technique. The total cumulative skin effect in this method is 120 per cent S.E.D. (960 r), which is equal to the normal skin tolerance of this region. Therefore, the difference between 216 per cent S.E.D. (1,728 r) and 126 per cent S.E.D. (1,008 r), namely, 90 per cent S.E.D. (720 r) represents the increased tumor dosage obtained by the use of the shielded semilateral four port technique of irradiation of intraoral carcinoma.

Clinically, we have determined that 3 cm. of overlapping of the shielding is ample and safe. To further eliminate much of the tediousness and difficulty in shielding the neck and face regions with the customary leaded rubber sheeting, or lead sheeting, we designed the following adjustable leaded rubber sheeting. This is illustrated and is self-explanatory (see Fig. 5). The size of the area to be irradiated is determined by subtracting 12 cm. (4×3 cm.) from the circumference of the mid-section of the region to be irradiated. The result is divided by 4 (four areas). As an example: The circumference is equal to 48 cm., subtracting 12 cm. from this, 36 cm. is obtained. Dividing this by 4, 9.0 cm. is the width of the area to be irradiated. The adjustable shield is regulated to this width and to the length of the aperture desired by means of the clasps which permit the sheeting to be fastened at any desired position and dimension.

The centers of the fields to be irradiated are then marked with mercurochrome solution and dilute silver nitrate solution, and the adjusted leaded rubber shield is placed over this mark, so that the mark is in the exact center of the aperture in the shield. This is further facilitated by the small projecting tips of rubber on the shield which act as guides for the determination of the center of the shield, as is shown in Figure 5.

In the external roentgen irradiation of intraoral carcinoma, we employ the Pfahler-Kingery saturation method. A typical graphic representation of a case treated is submitted (see Fig. 6).

Although we have not adapted this method of direct roentgen irradiation to benign radiosensitive intracavitary lesions, it it apparent that it would be of great value if employed in these conditions. We wish to give this method a trial in the treatment of chronic hypertrophic tonsillitis, in which

operative procedures are contraindicated, for we believe that this would be an excellent field for this type of radiotherapy.

In the near future, we hope to report some of the results obtained in the use of this method in the treatment of intracavitary neoplasms. This paper is submitted primarily as a preliminary report.

In conclusion, we sincerely hope that this article will stimulate sufficient interest in the method of direct roentgen irradiation of intracavitary new growths to warrant a trial, and that it will prove to be a useful addition to the everincreasing and rapidly growing armamentarium of the radiation therapist.

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DETERMINATION OF DOSAGE FOR LONG RADIUM OR RADON NEEDLES*

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IN ORDER to use any method of radiation therapy in the most efficient manner, it is necessary to know the distribution of radiation in the volume of tissue being irradiated. The development of depth dose charts has been of great value in the progress of methods of external irradiation, with both radium and roentgen rays. Greater difficulties attend the obtaining of corresponding information for interstitial sources, but these have been overcome, to a certain extent, and approximate data obtained by experimental means for relatively short implants—up to 2.5 cm. in length.[4,5,6,8] With increasing clinical use of considerably longer implants or radium needles, it becomes important to know more about the distribution of radiation around them.

Stahel[5] and Mayneord[4] obtained their data by making direct measurements with very small ionization chambers, Stahel's having a volume of 2 cubic millimeters and Mayneord's of about 30 cubic millimeters. In Stahel's work, radium and ionization chamber were immersed in water. Mayneord's measurements were made in air; he assumes that the values in water would not be very different. Neither of these observers has published data for tubes over 2.5 cm. in active length.

Our information (Quimby,[6] and Quimby and Stewart[8]) was obtained by correlating the results of several biological and chemical experiments. These have all been discussed in detail in previous publications (loc. cit.). They comprise determinations of formation of necrosis in rabbit muscle, production of erythema on human skin, and bleaching of butter. Our final curves agree very closely with those obtained by the ionization measurements.

It would be very inconvenient to apply our methods to a study of considerably longer sources. The long tubes would have to have a radon content of several millicuries per centimeter, which means that a considerable exposure to radiation on the part of the experimenter would be inevitable. It is therefore advisable to see whether the desired information can be obtained in any other manner.

In a recent publication[7] I have developed a method for calculating the field about any radium tube in air. If the tube were placed in a denser medium, such as water or tissue, the intensity of radiation at any given point would differ from the amount at the corresponding point in air for two reasons: The absorption of radiation by the intervening matter would decrease the amount arriving at the specified point; the scattering from the surrounding matter would increase that amount. The two effects would tend to counteract each other; the question is how nearly they would accomplish this. This may be answered by comparing the calculated field for the tube of 2 cm. length with the experimentally determined field for the same tube in water or tissue.

In Figure 1, A, the field about a 2 cm. tube in water according to Stahel is shown by the curves. The numbers on these curves represent the percentages given in the original paper, the calculated values being made to agree at 100 on Stahel's curves (at 10 on Mayneord's). They are not the same as the percentages used subsequently in this paper, as defined in terms of radiation from a specified source. The calculated results for the same tube in air are indicated by the crosses. The agreement throughout is surprisingly good. In Figure

* Read at the Seventeenth Annual Meeting, American Radium Society, New Orleans, La., May 9–10, 1932.

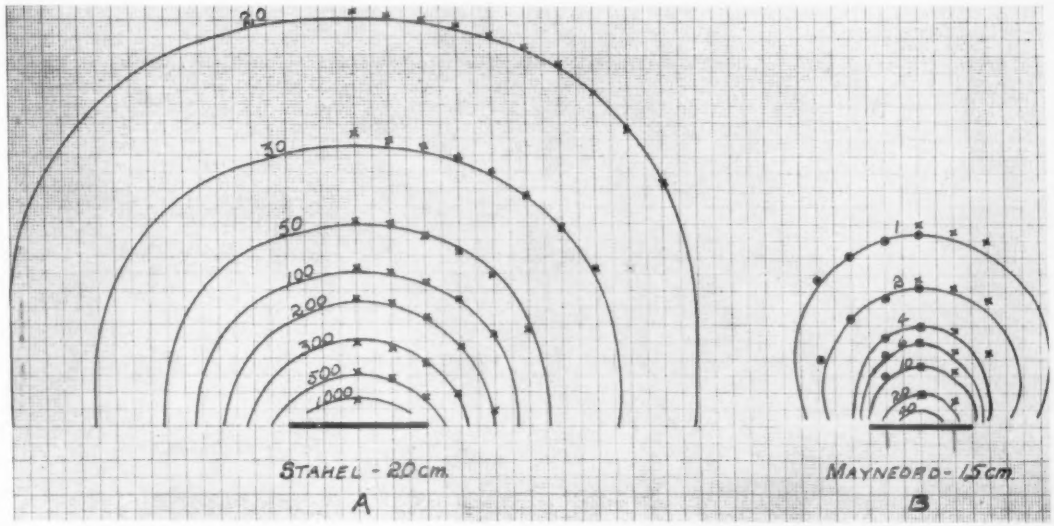

FIG. 1. Comparison of calculated and experimentally determined distribution of radiation around radium needles having a filter of 0.5 mm. Pt, and lengths as indicated. Curves indicate experimental values; points, calculated.

1, B, a similar comparison is made with Mayneord's data. The curves indicate the field found by him for a 1.5 cm. needle. The crosses represent the calculated points for a 1.5 cm. tube, the circles for a 1.0 cm. tube. The latter agree better with the experimental results, suggesting that the radium-bearing part of the needle was shorter than had been supposed. Other factors that might contribute to the difference in the shapes of the curves of Stahel and Mayneord in this instance are the size and shape of the ionization chamber used, the filter, the presence or absence of water, etc.

In Table 1 a comparison is made between the calculated data and the average of our experimental results previously published (loc. cit.). In the latter case only the distribution along the line perpendicular to the center of the tube is available, so that this comparison can be made only along this line. As in the charts, the values are forced to agree at a distance of 1 cm., and it is evident that, up to a distance of 2 cm. there are no variations as great as 10 per cent. Beyond this the experimental values become increasingly larger than the calculated until at 4 cm. the discrepancy is 25 per cent. It is therefore important to obtain a further check on the values at these distances. The experimental values

TABLE I

COMPARISON BETWEEN CALCULATED AND EXPERIMENTALLY DETERMINED VALUES OF INTENSITY OF RADIATION AT DIFFERENT DISTANCES PERPENDICULAR TO THE CENTER OF A RADIUM TUBE 2.0 CM. LONG WITH A FILTER OF 0.5 MM. PT

Distance	Intensity	
Cm.	Calculated	Experimental
0.5	235	275
0.75	133	135
1.0	82	82
1.25	55	55
1.5	40	40
1.75	31	31
2.0	23	25
2.5	16	17
3.0	11	13
4.0	6	8

this far from the needle are obtained entirely from the bleaching of butter, neither of the other methods being applicable at such distances. As a check on the values to be used, the relative intensities of radiation at these distances have been deter-

TABLE II

VARIATION OF INTENSITY OF RADIATION WITH VARIATION OF DISTANCE FROM RADIUM TUBE 2 CM. IN LENGTH

Distance	Intensity of Radiation				
Cm.	Inverse Square (Point)	Calculated (Tube)	Experimental (Tube)		
			Photographic	Ionization	Butter
1.5	40	40	40	40	40
2.0	23	23	23	23	25
2.5	15	16	15	15	17
3.0	10	11	10	11	13
4.0	6	6	6	7	8

mined photographically and by ionization. For the photographic tests, beeswax was used as the scattering medium, the tube being embedded in the wax, and slabs of wax being placed between the tube and the film, and above the film. For the ionization measurements, a thimble chamber was used. Chamber and radon tube were submerged to a depth of 10 cm. in water. The data are given in Table II, where, in addition, are given the inverse square law values for the point source, the butter values, and the calculated data. The intensities are based on 40 per cent at 1.5 cm., the last point at which the values of Table I agree. It is evident that the butter values are higher than all the others, which agree quite well among themselves. It seems, therefore, that the calculated values are at least as apt to represent the conditions as the butter data, at these distances, while at the shorter ones, which are more important in interstitial irradiation, the two agree.

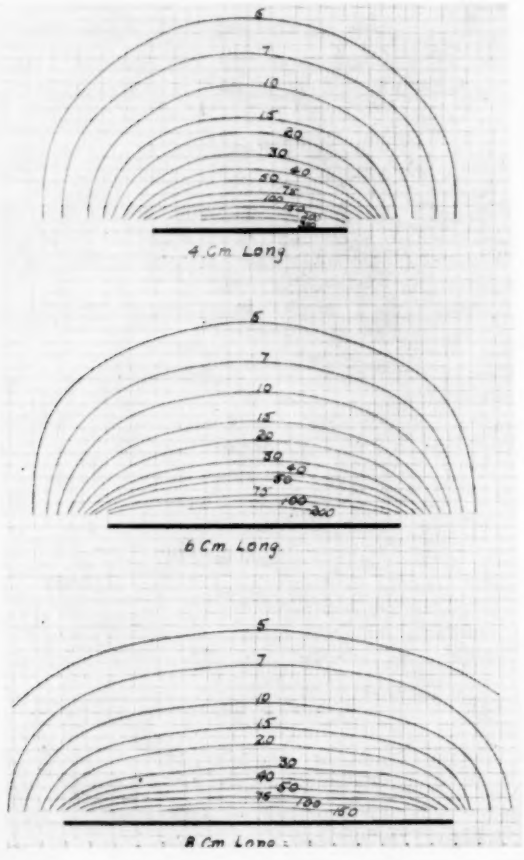

FIG. 2. Distribution of radiation about 4, 6, and 8 cm. needles.

On the basis of these comparisons between calculated and experimental data for 1.5 and 2.0 cm. implants, it is reasonable to assume that the calculated data for the longer ones would be accurate enough to serve as a satisfactory first approximation to the actual distribution in tissue.

The calculations for a 4 cm. tube in air have already been published[7]; those for 6 and 8 cm. tubes have been made in the same manner. From these have been drawn the charts of Figure 2, showing the field around these implants. In these charts, 100 per cent corresponds to the intensity from a point source of the same strength and filtration as each tube or needle, at a dis-

tance of 1 cm. These charts, or curves constructed from them, may be used to map the field around any combination of implants, in the same way as those previously published were used for external applicators.

surface of the needles to a minimum half way between them. For four or more needles in a plane, radiation half way between two at the end of the series will be less than that between two at the middle. If a needle is added at one end of the series, it does not in-

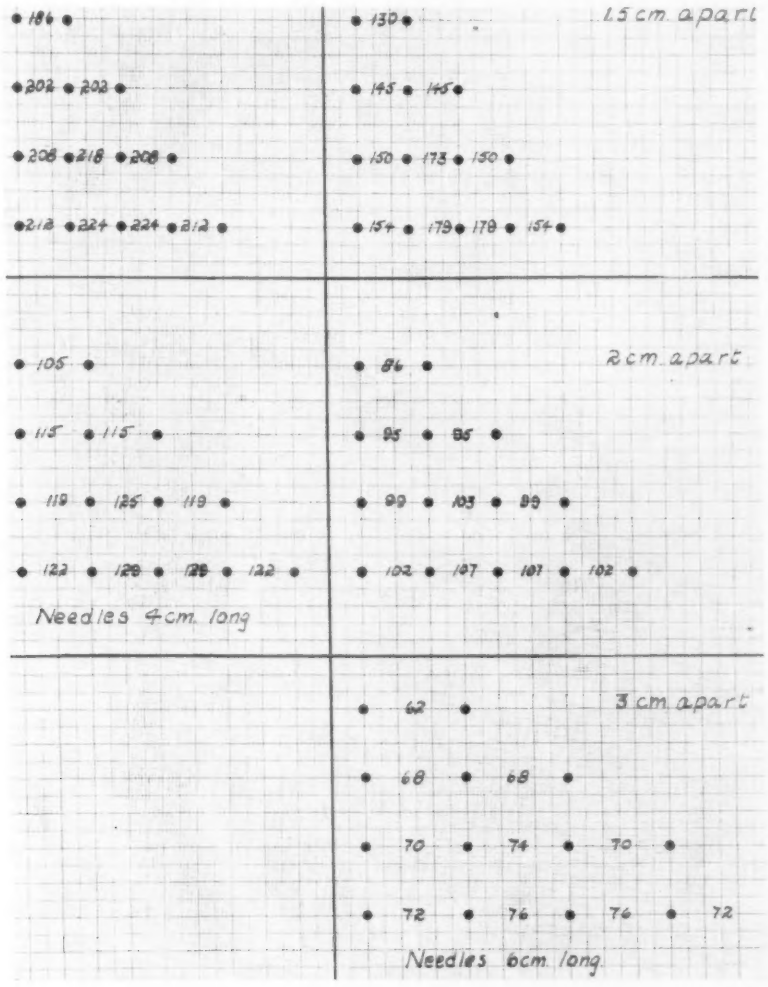

Fig. 3. Variations of intensity of radiation along line of centers of implants, for various groups of 4 and 6 cm. needles. Numbers indicate relative intensities at points midway between adjacent needles.

The fundamental groups of needles will usually be several placed parallel to one another in a plane, separated more or less widely. The number to be used will depend on the volume of tissue to be irradiated and the dose to be delivered. In the plane of the needles, the dose will, of course, vary enormously from a maximum at the

crease very much the radiation at the other end. If one is added at each end of the series, it will increase the dosages throughout by varying amounts, depending on the spacing and the number of needles already present. Also, of course, adding needles in this manner increases the volume of the irradiated tissue. Figure 3 gives, for 4 and

6 cm. needles, illustrations of the variations in intensity in the plane of the centers of the implants, with variations in their number and spacing. The numbers represent the relative intensities midway between each two needles.

For purposes of visualizing the field about such a set of needles, calculations have been made for five, each 6 cm. long, spaced 1.5, 2.0, and 3.0 cm. apart. The results are shown in Figure 4. It is evident that the closer spacing gives a much higher intensity of radiation within the volume near the needles and also that the isodose lines are smoother. With the wide spacing there is considerable irregularity in these, even at some distance from the needles.

Of course the "isodose" surfaces taper towards the ends of the needles; their cross-sectional area is a maximum at the center. The rate of decrease from this point towards the ends of the needles may be judged approximately from the charts of Figure 2. From these it is seen that at distances of 1 or 2 cm. from the needles, half way from the center to the end the intensity is about 10 per cent less than at the center; three-quarters of the way it is from 20 to 30 per cent less; at the ends it is from 40 to 50 per cent less.

The actual dose of radiation delivered in the tissues by these needles is, of course, important, as well as the relative doses in different parts of the field. It is especially necessary to know the minimum dose delivered within the volume irradiated, for the cells receiving this dose are the most likely to survive. Thus far, all numbers

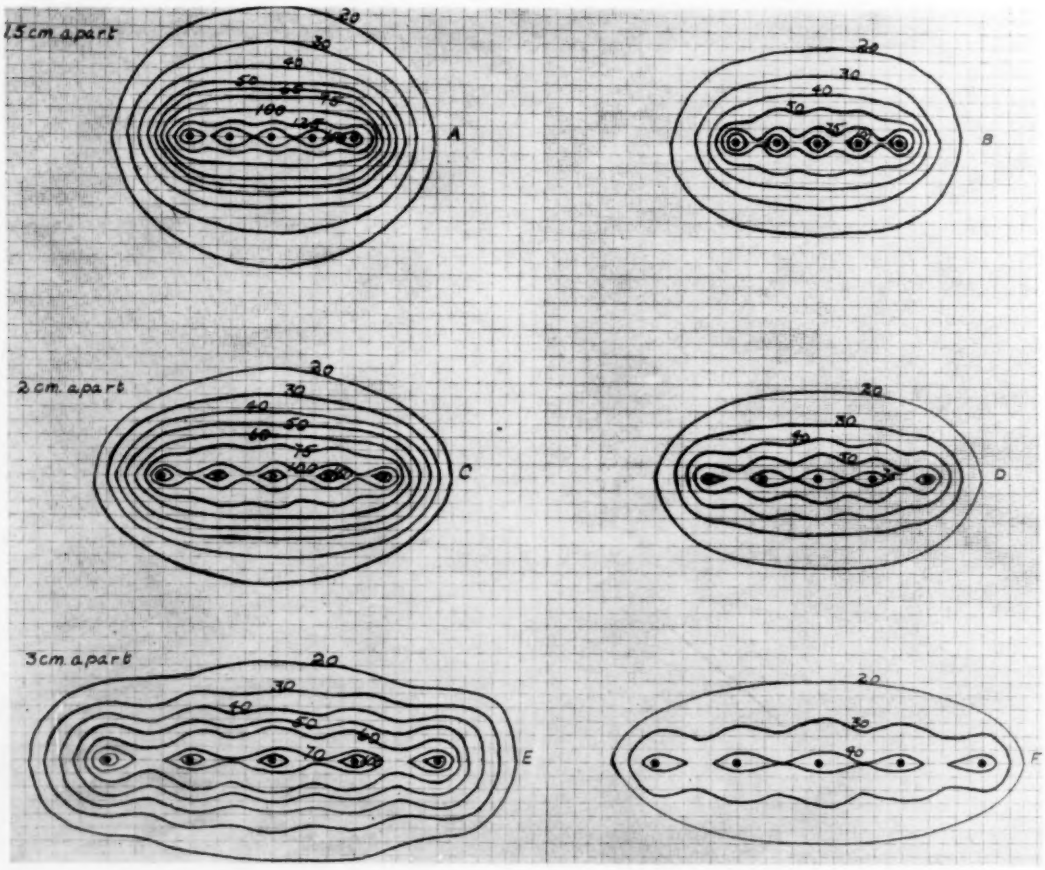

FIG. 4. Distribution of radiation about various groups of 6 cm. needles, in planes perpendicular to the needles, at their centers (A, C, E) and at their ends (B, D, F).

have represented percentages of the intensity of radiation from a point source, of arbitrary strength, at a distance of 1 cm. Now, it has been previously shown[2] that a gold implant or "seed," which we may consider practically as a point source, delivers one "erythema dose" at a distance of 1 cm. by an irradiation of approximately 100 mc-hr. (total decay of a seed of 0.8 mc.). It has been pointed out that the assumption of this amount of radiation as an "erythema dose," when it is extended over the entire life of the seed, is artificial. It would actually take considerably more than this amount to produce a threshold erythema under these circumstances. Experiments are at present under way which, it is hoped, will give information as to the necessary increase in dose with prolongation of time, for the production of a visible erythema. Meantime, 100 mc-hr. at a distance of 1 cm. from a point source in tissue will be taken as an arbitrary "erythema dose."

Returning to the charts of Figures 3 and 4, in which all the numbers indicate the percentage of the intensity of radiation from a point source at a distance of 1 cm., it is now possible to translate these into terms of dose delivered by a specific set of implants. If 100 per cent is to represent 1 erythema dose, this means that all the needles of a group must together have delivered at the point receiving 100 per cent, as much radiation as would have been delivered at 1 cm. distance by 100 mc-hr. from a gold seed. Or, in other words, the numbers represent the percentage of an erythema dose delivered by the whole group of needles together, for an irradiation of 100 mc-hr. from each one. Then, in order to deliver a minimum of one erythema dose (100 per cent) within a region enclosed in a shell marked 60 per cent, it would be necessary to use $100/60 \times 100 = 167$ mc-hr. from each needle. To deliver a minimum of 8 erythema doses within this region would, of course, require 8 times as much, or 1,360 mc-hr. per needle.

With the use of large doses of interstitial radiation, the problem of necrosis becomes important. The relationship between the erythema and necrosis doses is not very well known. On the basis of the rabbit experiments already quoted, it is found that 20 erythema doses produce complete necrosis.* Referring again to Figure 4, it is seen that, with the 1.5 cm. spacing between adjacent needles, for a zone about 0.5×1.0 cm. in area around the center of each needle, an intensity of 150 is indicated. If the 60 per cent zone receives 1 erythema dose (100 per cent), this 150 per cent zone will receive $2\frac{1}{2}$ erythema doses ($60/100 = 150/250$). If the 60 per cent zone is to receive 8 erythema doses, then the 150 per cent zone will receive 20 erythema doses ($2\frac{1}{2} \times 8 = 20$). With such a dose, the tissue inside this zone will undergo necrosis.

If the needles are more widely spaced, the zone of necrosis might be expected to be somewhat smaller. For instance, with the 2 cm. spacing, the 150 per cent zone is much smaller than with the 1.5 cm. distances; the 100 per cent zone in this case in only slightly larger than the 150 per cent zone in the former. On the other hand, at the distance at which the first (1.5 cm.) spacing gave 60 per cent, namely 1.75 cm. from the plane of the needles, the second (2 cm.) gives about 50. Therefore, in order to deliver the same dose of radiation at this point, it is necessary to use 60/50 times as many millicurie-hours, or 195 mc-hr. per needle. In order to deliver 8 erythema doses at the same point as before, there will be required 1,600 mc-hr. per needle. With this irradiation the zone marked 100 per cent will receive 16 erythema doses, the one marked 150, 24 erythema doses. Necrosis will begin somewhere between them. Evidently, for these two spacings (1.5 cm. and 2 cm.) there is little difference in the volume of necrosis per needle when a minimum of 8 erythema doses is delivered

* It must be remembered in this connection that the tissue under consideration is muscle, and that the question of infection does not enter. Also these doses were delivered over a period of several days. The situation is not comparable to the production of necrosis in the skin by a considerably smaller dose of external radiation with a much higher intensity.

through a diameter 3.5 cm. perpendicular to the needles at their centers, while the dose is more economically delivered with the closer spacing, when the same number of needles is used.

The relations here discussed may be better visualized with the aid of Figure 5. In *A*, with 5 needles spaced 1.5 cm. apart, for a dosage of 100 mc-hr. per needle, the point *P* will receive 60 per cent of an erythema dose. To deliver 8 erythema doses at this point will require 1,360 mc-hr. per needle. In *B*, with the needles spaced 2 cm. apart, the same point *P* receives only 50 per cent of an erythema dose for 100 mc-hr. per needle. Hence, with this arrangement, it requires 1,600 mc-hr. per needle to deliver 8 erythema doses at this point. It must be noted, however, that four needles with the second spacing will cover the same volume as five with the first, as shown in *C*. If the number of needles is decreased from five to four, the intensity at the point *P* (for a 2 cm. spacing) will be decreased by about 10 per cent, namely to 45. Then to deliver one erythema dose at this point will require 10 per cent more radiation, or 220 mc-hr. per needle, and to deliver 8 erythema doses will require 1,760 mc-hr. per needle. This amount will have to be given by each of four needles, a total of 7,040 mc-hr. With five needles 1.5 cm. apart, each had to deliver 1,360 mc-hr., a total of 6,800 mc-hr. The difference is negligible. With regard to the region of necrosis, there is again little difference. With the four needles, the volume per needle is slightly larger than with the five (the mc-hr. per needle having been increased), so that the final result will be about the same.*

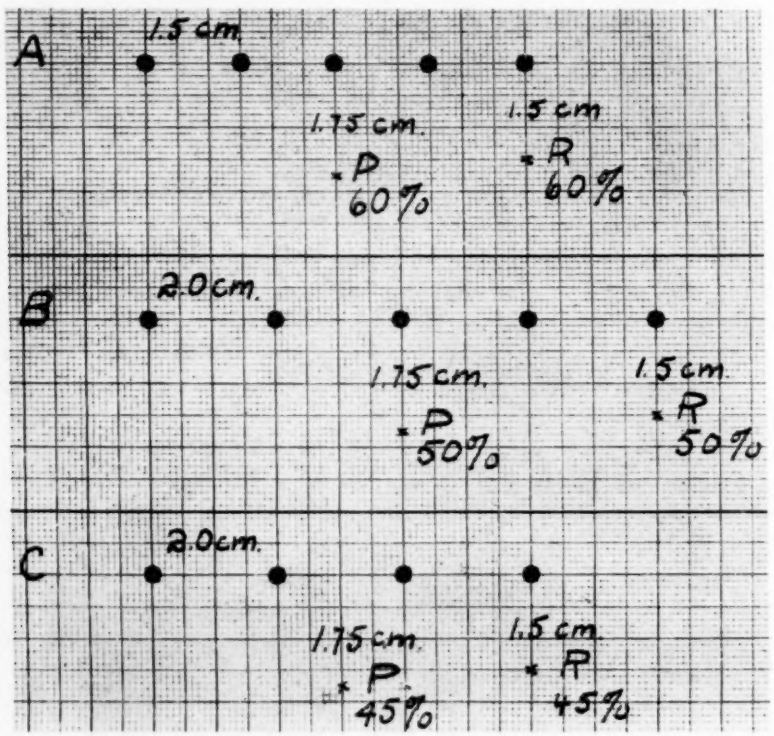

Fig. 5. Variations in dose at specified points for different arrangements of 6 cm. needles in one plane (100 mg-hr. per needle).

* It must be remembered that the calculations of necrotic volume can only be regarded as approximations. In the first place, the establishment of 20 erythema doses as the necrosis dose is based only on experiments with rabbits: it may be quite different for human tissue. Again, for distances from the needles as

The point P so far considered has indicated the maximum distance from the plane of the needles at which the specified dose is delivered. If the two outermost needles are placed at the edges of the lesion, then the distance from these at which the same dose is delivered will be the minimum distance for this dose, that is, every point that near or nearer to the plane of the needles will have received the specified dose. This point is indicated by R, in each part of Figure 5.

From this discussion it is evident that a minimum of 8 erythema doses may be delivered through a region 5 or 6 cm. wide and 3 cm. thick by means of needles 6 cm. in length, spaced 1.5 or 2 cm. apart along its central plane. There is little choice between the two arrangements as regards amount of radiation used, or volume of necrotic tissue produced. By a similar line of reasoning it may be shown that accomplishing the same irradiation by means of needles placed 3 cm. apart is not so satisfactory. It would require considerably more radiation than the other arrangements, and a glance at Figure 4 shows that the distribution of radiation at the distance in question is quite irregular.

The most desirable method of irradiating any specified mass may be worked out along these lines. However, data will be given later in the paper which will simplify the calculations necessary.

The above considerations indicate that any mass of tissue not more than 3 or 4 cm. in thickness may be adequately irradiated by the use of a series of needles distributed in its central plane, parallel to one another and not too widely separated. As the thickness increases, of course the mc-hr. per needle necessary to deliver a large dose at the periphery increases also. Evidently for very thick lesions, the radiation per needle would become so large that grave overdosing, with consequent necrosis, would occur in the central portion of the mass. In this case it becomes necessary to use two (or more) series of needles in parallel planes. A similar arrangement may also be used if it is deemed advisable not to insert the needles into the tumor mass. In this case

FIG. 6. Variations in dose at specified points for different arrangements of ten 6 cm. needles in two parallel planes.

they would be distributed in planes on both sides of it.

With such an arrangement, the intensity of radiation at any point in the plane perpendicular to the needles at their centers can be calculated from Figure 4 (for 6 cm. needles). The effect of different spacings, with distances of 2, 3, and 4 cm. between the planes, still for 6 cm. needles, is shown in Figure 6. From these diagrams it seems that for uniform irradiation throughout the mass (or as nearly uniform as can be achieved) the needles in each plane should be spaced just about as far apart as the dis-

small as those involved in the necrosis determinations, readings from the curves cannot be made with any degree of accuracy.

tance between the two planes of needles. If it seems advisable to irradiate the margins of the mass more strongly than the center, the needles should be placed closer together than the distance between the planes. It is not advisable under any circumstances to place them farther apart than this distance.

On the basis of these figures it is possible to calculate approximately the dose delivered by a certain number of mc-hr. (or mg-hr.), or the number of mc-hr. required to deliver a certain dose, *for these particular arrangements*. For instance, from Figure 6, ten 6 cm. needles placed 2 cm. apart in two planes which are 3 cm. apart, five needles in each plane, deliver a minimum intensity of 130 per cent on the periphery, and 90 per cent within the mass, for an irradiation of 100 mc-hr. per needle. Or, if the end needles have been placed 1 cm. beyond the mass, the minimum within it is 100 per cent. These doses are for points in line with the centers of the needles. It will be assumed that the needles are long enough to extend completely through the mass and protrude at each end, leaving about 75 per cent of the active portion of the needle within the mass. It has been seen that three-quarters of the way from the center to the end of the needle the intensity is about 75 per cent of what it is at the center. Therefore, for the actual minimum doses, the above numbers will have to be reduced to 75 per cent of their value, or 100, 65, and 75 per cent. That is, for 100 mc-hr. from each needle, the point of minimum dose within the mass receives three-quarters of an erythema dose. These needles are 6 cm. long; if their strength is 1 mc. (or 1 mg.) per cm., they contain 6 mc. (or mg.) each, or a total of 60 mc. for the 10 needles.* If a total irradiation of 600* mc-hr. per needle is used, the point of minimum dose will receive 6 times three-quarters, or $4\frac{1}{2}$ erythema doses.

By a converse operation, the number of millicurie-hours necessary to deliver a specified dose can be determined. Thus, if a minimum of 8 erythema doses is desired, with this particular arrangement of needles, since 100 mc-hr. per needle gives 0.75 of an erythema dose, it will require $8/0.75 \times 100 = 1{,}066$ mc-hr. per needle.

The same dose could, of course, have been delivered by half as many needles inserted in the middle of the mass, as discussed above. In this case the charts of Figure 4 apply. The minimum dose will be delivered on the periphery (that is, 1.5 cm. above the end needle, in a direction perpendicular to the plane of the needles), and, for a radiation of 100 mc-hr. per needle will evidently be 55 per cent of an erythema dose opposite the centers of the needles. Three-quarters of the way from the center toward the ends of the needles it will be 0.75 of this, or 40 per cent. In order to deliver 8 erythema doses at this point, it is necessary to use $8/0.40 \times 100 = 2{,}000$ mc-hr. per needle. Since there are now five needles instead of ten, the total amount of radiation used will be 10,000 mc-hr., as compared to 10,670 with the above arrangement of ten needles. The 7 per cent difference between the two totals is not significant.

It is therefore important to see what advantages lie with each method of treatment. In the first place, what difference, if any, exists in the volume of necrotic tissue produced in the two cases? We may assume that in the production of necrosis, needles 2 cm. or more away have a negligible effect, and consider it as solely due to the needle which it encloses. We have taken 20 erythema doses as the necrosis dose, and we can find the radius for this dose for any given needle from Figure 2. In the first (ten needle) arrangement, each needle is used for approximately 1,070 mc-hr. This amount delivers at a point indicated by an intensity of 75 per cent, 8 erythema doses. Then the point which will

* When radium needles are used, since the strength is constant, the millicurie-hours are always the product of the strength of the needle and the time of irradiation. On the other hand, if the needles contain radon, allowance must be made for the decay of the gas and the millicurie-hours calculated by means of the formula:—mc-hr.$= 133\ I_0\ (1-e^{-0.0075T})$, where I_0 is the initial strength of the source, e the base of natural logarithms, and T the time, in hours.

receive 20 erythema doses should be indicated by an intensity of $20/8 \times 0.75 = 188$. This is at a distance of 4 mm. from the axis of the 6 cm. needle. In the second (five needle) case, the point indicated by 40 per cent receives the 8 erythema doses, from which it is evident that 20 will be delivered at the point indicated by 100 per cent. This is at a distance of 5.5 mm. from the axis. Since the volume of necrosis increases approximately as the square of the radius, in the second case there will be $(5.5)^2/4^2 = 1.9$ times as much per needle. (This, of course, includes the actual volume of the needle in the volume of destroyed tissue.) Since there are only half as many needles in this second case, the total volume of necrotic tissue formed is practically the same in the two cases.

We may then sum up the facts regarding two methods of delivering the same minimum dose to a given lesion. In one case, two series of needles are used, placed in parallel planes just outside the neoplastic mass, in normal tissue; in the other, a single series is inserted directly into the mass itself. The actual expenditure of radiation is substantially the same. In the first method there is much less trauma in the lesion itself. The total volume of necrosis produced is about the same, but in the first case it lies in normal tissue and in the second it is in the middle of the diseased mass. In the first method, the heaviest irradiation is given to the normal tissues just outside of the mass; in the second, to the central portion of the lesion. In any specific case, it is for the clinician to decide which method is preferable.

Of course the need may arise for dealing with a mass so thick that two series of needles must be inserted within it. Or it may be considered desirable to put one series through the lesion and one series on each side of it. For such conditions the distribution of radiation can also be calculated, although of course the complexity of the arithmetical operations increases with the number of implants.

It would be an advantage to have a dosage table for needles similar to the one already published for gold seeds.[3] Unfortunately it is impossible to simplify the problem to the same extent. However, it is possible, as just illustrated, to determine the doses at specified points, for certain standardized groupings and spacings of needles, such as those of Figures 3, 4, and 5, and tabulate them in a usable manner. This has been done in Table III.

Since a spacing of 2 cm. has been shown to be satisfactory for the various arrangements already considered, it is used in the table. If it is desired to use other spacings, an approximation to the variation in dose may be obtained from Figures 3 and 5. Data are given for needles 4, 6, and 8 cm. in active length. In Part I the needles are considered as placed parallel in a single plane, as in Figures 3 and 4. In Part II, they are placed in two parallel planes as in Figure 5. For each set, *for an expenditure of 100 mc-hr. per needle* are given the percentages of an erythema dose at certain specified points, as indicated in the diagram of Figure 7, located in a plane perpendicular to the needles and three-quarters of the distance from their centers toward their ends. These may, therefore, be considered as the average doses for points in these positions relative to the needles.* The points are:

For Part I:

A—half way between two outside needles, in their plane.
B—1 cm. directly above A.
C—2 cm. directly above A.
D—in plane of needles, 1 cm. beyond outer one.

For Part II:

A—in plane midway between two series of needles, equidistant from four needles, as indicated.
B—in plane of one series of needles, midway between two outside ones.
C—1 cm. directly above B.
D—in same plane as A, 1 cm. outside needles.

* The values in Table III should not agree with those of Figures 3 and 6. The figures refer to planes through the midpoints of the needles, the table to planes through points three-quarters of the distance from the centers towards the ends of the needles.

TABLE III

DOSAGE TABLE FOR RADIUM OR RADON NEEDLES 4 TO 8 CM. IN ACTIVE LENGTH. DOSES FOR SPECIFIED POINTS (SEE FIG. 7) IN PLANE PERPENDICULAR TO PLANES OF NEEDLES, AND THREE-QUARTERS OF THE DISTANCE FROM THE CENTERS TOWARDS THE ENDS. NEEDLES 2 CM. APART; 100 MG-HR. PER NEEDLE

Part I

All needles in a single plane

Point	Percentage of erythema dose at specified point		
	4 cm. Needles	6 cm. Needles	8 cm. Needles
	2 Needles—200 mg-hr. Total		
	Area 2×3 cm.*	Area 2×4.5 cm.	Area 2×6 cm.
A	75	65	
B	50	40	
C	25	20	
D	45	40	
	3 Needles—300 mg-hr. Total		
	Area 4×3 cm.	Area 4×4.5 cm.	Area 4×6 cm.
A	85	75	60
B	60	45	40
C	35	25	25
D	50	45	35
	4 Needles—400 mg-hr. Total		
	Area 6×3 cm.	Area 6×4.5 cm.	Area 6×6 cm.
A	85	75	65
B	60	50	45
C	35	30	25
D	50	45	40
	5 Needles—500 mg-hr. Total		
	Area 8×3 cm.	Area 8×4.5 cm.	Area 8×6 cm.
A	90	80	65
B	65	50	45
C	40	30	30
D	55	45	40
	6 Needles—600 mg-hr. Total		
	Area 10×3 cm.	Area 10×4.5 cm.	Area 10×6 cm.
A	90	80	65
B	65	50	45
C	40	30	30
D	55	45	40

* The areas given are based on the assumption that the two outside needles are placed at the sides, and that the needles extend beyond the ends of the mass so that three-quarters of the active portion is included within it.

TABLE III (*Continued*)

Part II

Needles in two parallel planes

	1. Planes 2 cm. apart.		
	2 Needles per plane—400 mg-hr. Total		
	Area 2×3 cm.	Area 2×4.5 cm.	Area 2×6 cm.
A	100	85	
B	100	85	
C	65	55	
D	65	55	
	3 Needles per plane—600 mg-hr. Total		
	Area 4×3 cm.	Area 4×4.5 cm.	Area 4×6 cm.
A	115	100	80
B	115	100	80
C	80	65	55
D	75	60	50
	4 Needles per plane—800 mg-hr. Total		
	Area 6×3 cm.	Area 6×4.5 cm.	Area 6×6 cm.
A	125	110	90
B	125	110	90
C	85	75	60
D	80	65	55
	5 Needles per plane—1000 mg-hr. Total		
	Area 8×3 cm.	Area 8×4.5 cm.	Area 8×6 cm.
A	130	115	95
B	130	115	95
C	85	75	65
D	85	70	60
	2. Planes 3 cm. apart		
	2 Needles per plane—400 mg-hr. Total		
	Area 2×3 cm.	Area 2×4.5 cm.	Area 2×6 cm.
A	75	60	50
B	90	80	65
C	75	50	40
D	65	40	35

Table III (*Continued*)

	3 Needles per plane—600 mg-hr. Total		
	Area 4×3 cm.	Area 4×4.5 cm.	Area 4×6 cm.
A	90	70	60
B	105	90	75
C	80	60	50
D	70	45	40
	4 Needles per plane—800 mg-hr. Total		
	Area 6×3 cm.	Area 6×4.5 cm.	Area 6×6 cm.
A	95	75	65
B	110	95	80
C	85	65	55
D	75	50	45
	5 Needles per plane—1000 mg-hr. Total		
	Area 8×3 cm.	Area 8×4.5 cm.	Area 8×6 cm.
A	100	80	70
B	110	100	85
C	85	70	60
D	80	55	45

From this table it is possible to estimate the minimum dose delivered within a volume of tissue by a given number of mc-hr. or mg-hr. of radiation, or to decide how many mc-hr. (or mg-hr.) should be given to deliver a desired dose. The length of the needles to be used will be determined by the size of the mass. They should be spaced about 2 cm. apart. The number used depends on the volume to be irradiated.

For example, suppose five 8 cm. needles, each having a strength of 8 mg. (1 mg. per cm.) to have been distributed parallel to one another about 2 cm. apart in a breast, and left for 6 days. This means an irradiation of 144 hours, or 1,152 mg-hr. per needle. It is desired to know the minimum dose delivered in a mass of tissue 4 cm. thick (2 cm. on each side of the plane of the needles). This would correspond to the dose at point C of Part 1. For five 8 cm. needles, this point receives 30 per cent of an erythema dose for every 100 mg-hr. per needle. Hence, with an irradiation of 1,150 mg-hr. per needle, the total dose will be $1{,}150/100 \times 30 = 345$ per cent, or 3.45 erythema doses.

As a further example, suppose it is desired to deliver a minimum of 5 erythema doses throughout a volume of tissue $3 \times 5 \times 7$ cm. This can be done in several ways. Using all needles in the central plane, the mass can be covered by five 6 cm. needles running parallel to the 5 cm. diameter, or by four 8 cm. needles running parallel to the 7 cm. diameter. Using needles in two planes, it is possible to place them so that both series are in the mass itself, each 1 cm. from the central plane (planes 2 cm. apart), or to place each series just outside the mass (planes 3 cm. apart). In either of these two series arrangements, the needles could be distributed as in either of the single plane schemes. The minimum dose for each distribution can be found. In the single plane method, the periphery of the mass, which will receive the minimum dose, will fall between points B and C. For five 6 cm. needles this is between 30* and 50 per cent

* The values in the table are given to the nearest 5 per cent of

of an erythema per 100 mg-hr. per needle, —say it is 40 per cent. Then to deliver 5 erythema doses at this point will require $500/40 \times 100 = 1{,}250$ mg-hr. per needle, for five needles, a total of 6,250 mg-hr. For four 8 cm. needles, the value in the table is between 25 and 45, say 35. This will require a dose of 1,430 mg-hr. per needle. In this case there are only four needles, making a total of 5,720 mg-hr. If two series of needles are used 2 cm. apart, the periphery of the zone to be treated will be between points B and C. These values are very different and it would probably not be correct to take their mean, but something closer to C. For five 6 cm. needles per plane, say 90. Then 5 erythema doses require 555 mg-hr. per needle, or a total of 5,550 for ten needles. If these same needles are used in planes 3 cm. apart, that is, on the margins of the mass in question, the minimum will be at point A, in the center. This, in this case (five 6 cm. needles per plane) receives 80 per cent per 100 mg-hr. per needle, which indicates the necessity of using 625 mg-hr. per needle, or a total of 6,250 mg-hr. for 5 erythema doses. Using two series of four 8 cm. needles in a similar manner we arrive at totals of 5,720 and 6,150 mg-hr.

Here are six possibilities for delivering the same minimum dose in a given mass, using from four to ten needles, in which the maximum variation in total dosage is 12 per cent. What, if any, are the relative advantages of each? The first two require the use of fewer needles, with less consequent trauma. On this basis the advantage is with the longer needles, for fewer are required. However, from a purely mechanical standpoint it would probably be more difficult to get the longer ones into the desired positions. This would depend partly on the anatomical location of the mass. Using a single series of needles in this manner, the irradiation would be much more intense along the central plane of the mass, decreasing toward the periphery. Using two series of needles in the tumor would mean the production there of considerably more trauma. On the other hand, the irradiation throughout the mass would be more nearly uniform than with any other method of interstitial irradiation.

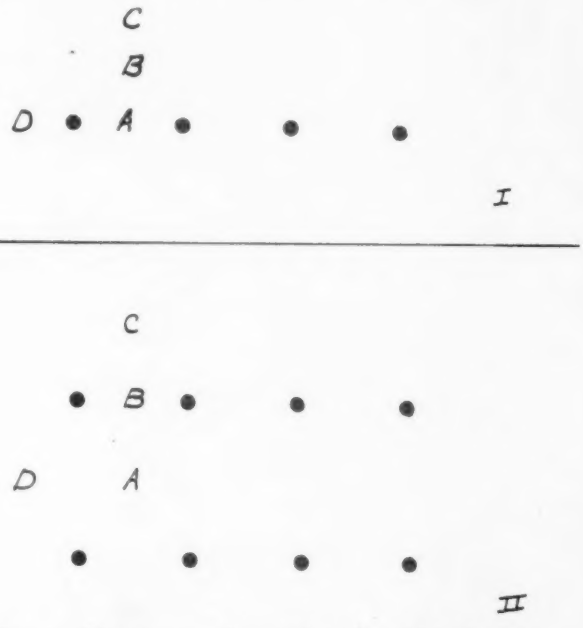

Fig. 7. Diagram to show points for which dosage calculations are tabulated. To accompany Table III.

With the two series of needles outside the tumor, much of the trauma to the lesion itself would be avoided. The margins of the growth and the surrounding normal tissue would now be more heavily irradiated than the center. In all cases the amount of necrosis produced would be about the same, but with the single series, or the two 2 cm. apart, it would be formed in diseased tissue, while with the 3 cm. spacing it would be partly, at least, in normal tissue. Using ten needles, the volume of necrosis per needle would be only half as much as using five, so that the destroyed tissue would be more readily absorbed.

Apparently no one method has outstanding advantages over the others. For a given mass of tissue, about the same number of mg-hr. will be required, and about the same amount of necrosis produced, for any

an erythema dose. An attempt at greater accuracy than this is not warranted by the nature of the data.

practical distribution of needles, in order to deliver therein a given minimum dose of radiation. As stated above, in any particular case the method of choice must be determined by the clinician.

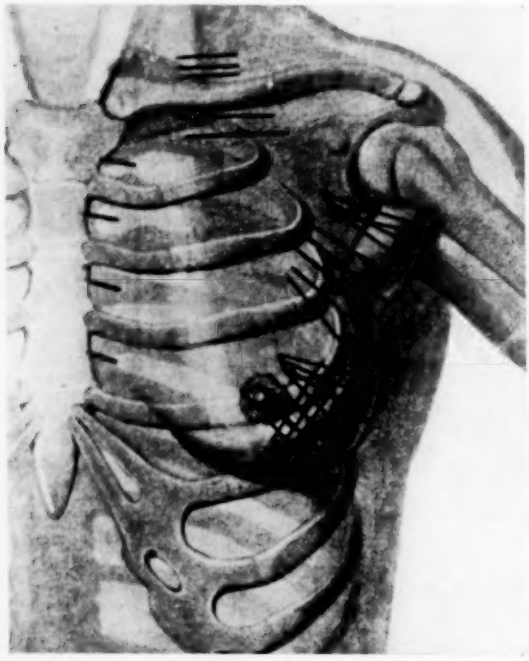

FIG. 8. Typical distribution of radium needles in carcinoma of the breast, as used by Keynes. The position of the growth is indicated by a dotted line.

It is of interest to calculate the total dose delivered when a comprehensive scheme of irradiation by means of long needles is carried out. Keynes[1] is one of the foremost exponents of this method of treatment, and Figure 8, taken from his paper just referred to, shows the typical distribution used by him. All needles are left in place for an average period of seven days. In calculating the doses, each group may be considered by itself, for we have already seen that adding needles beyond a group of three or four does not increase materially the dose in their neighborhood. The groups will be considered as follows:

I. *The Primary Growth.* Several needles 4.8 cm. long (active portion) spaced 1.5 cm. apart, to cover the whole of the primary growth and the breast tissue for some distance around it. These needles are placed in a plane "deep to the growth." If the growth is a large one, a second series of these needles is used, in a plane superficial to the first. (The distance between these planes is not stated.) These needles contain 3 mg. of radium each, and therefore each delivers approximately 500 mg-hr. in seven days. Suppose for a typical case that two series of six needles each have been placed above and below the lesion, which is 3 cm. thick, and well within the region covered by the needles. From Figure 5, the minimum intensity for this distribution is seen to be delivered at the center of the mass. According to Keynes, the most important point to consider is on the periphery of the growth. These center and peripheral points correspond to points A and B of the table, Part II. For six needles per series the doses at these points would be essentially the same as for five. For a 2 cm. spacing of 4 cm. needles these doses are respectively 100 and 110 per cent of an erythema dose for 100 mg-hr. per needle; for 6 cm. needles they are 80 and 100 per cent. For needles 4.8 cm. long, they would be about 90 and 105 per cent. Now, from Figure 5, if the needles are spaced 1.5 cm. apart instead of 2 cm., the doses at points A and B will both be increased by about 40 per cent. Therefore, for this latter arrangement, these points will receive approximately 125 and 145 per cent of an erythema dose per 100 mg-hr. per needle. This means that with the irradiation specified above, 500 mg-hr. per needle, they will receive respectively 625 and 725 per cent—$6\frac{1}{4}$ and $7\frac{1}{4}$ erythema doses—for the full treatment.

II. *The Lymphatic Drainage.*

(*a*) Pectoralis major. Three to five of the same needles beneath the pectoralis major muscle, to catch the main lymph channels draining the breast. Four such needles would deliver, at a distance 2 cm. above or below their plane, four erythema doses.

(*b*) Axilla. Three to five of the same needles in the axilla, distributed on its various walls. This might be calculated for

point C of two planes of 2 needles each, placed 2 cm. apart. This point would receive $4\frac{1}{4}$ erythema doses.

(*c*) Infraclavicular region. Two or three needles 3 cm. long, each containing 2 mg. of radium, and delivering in one week 340 mg-hr. Such needles would deliver, at a point 1 cm. from their plane, approximately 5 erythema doses.

(*d*) Supraclavicular region. Essentially the same as (*c*).

(*e*) Intercostal spaces. Three or four of the shorter needles, as shown in Figure 8. These will be several centimeters apart and will not deliver any sort of uniform irradiation. There will be minima of about 2 erythema doses midway between the members of each pair.

The effect of any group of needles on the region occupied by any other group will be small, as already stated. Therefore this scheme of treatment irradiates the primary growth and its surrounding tissues with a minimum of from 6 to 8 erythema doses, and the principal drainage areas with a mimimum of from 4 to 5 erythema doses.

By means of a similar series of calculations, an approximation may be made to the dosage delivered with any practical scheme for irradiation with long needles. If the needles are supplemented by seeds or by external irradiation, the doses from these sources may be calculated independently and added to the total.

SUMMARY

Calculated and experimental data regarding the distribution of radiation around certain radium needles have been shown to agree. Calculations for longer needles have been made in the same manner, and the results used in developing a method for the determination of tissue dosage when such needles are used interstitially. Charts are given of the radiation distribution around single needles 4, 6, and 8 cm. in active length, and around certain typical groups of these needles.

It is shown that when a series of needles are placed in a plane parallel to one another and uniformly spaced, the addition of needles at one end of the series has very little effect on the dose of radiation delivered at the other end. This may be extended to the statement that groups of a few needles at distances of several centimeters from other similar groups produce very little change in the effect of any group within its own volume.

The "threshold erythema" is taken as the unit of tissue dosage, and a relation is given whereby the calculated data can be expressed in terms of this unit. (This unit has been used in all dosage data published from Memorial Hospital. It is used with the statement that it is an arbitrarily established unit for irradiations of more than a few hours' duration.)

It is shown that, experimentally, about 20 erythema doses are required to produce complete necrosis in rabbit muscle. This dose is used in calculating the volumes of necrosis produced in interstitial irradiation. It is not comparable to the dose which, delivered externally in a short period of time, will produce necrosis in the skin. It is found that, for a given total number of millicurie-hours or milligram-hours the amount of necrosis produced is substantially the same whether few or many needles are used, within practical limits.

The question of the proper spacing of the needles is investigated. For a single series of parallel needles, distances of 1.5 to 2 cm. are recommended. For two series in parallel planes, the needles should never be placed farther apart than the distance between the planes, and closer spacing may be advisable. Needles should always be sufficiently long for the active portion to extend completely through the lesion.

For a mass of a given size, about the same number of millicurie-hours or milligram-hours are required to deliver a specified minimum dose, for any practical arrangement of the needles. The amounts of necrosis produced will also be about the same. It is therefore possible to determine, in any given case, what arrangement should be used on the basis of (1) whether it is

desirable to avoid trauma by putting the needles in normal tissue; (2) whether it is desirable to avoid the production of necrosis in normal tissue by putting the needles in the lesion; (3) whether or not the periphery of the lesion and the normal tissue beyond it should receive much heavier irradiation than the interior of the mass.

Tables are given whereby, for a number of practical arrangements of needles, tissue dosage can be determined in specific cases. Examples are given to show the various uses of these tables.

I wish to express my thanks to Dr. Failla for advice and suggestions during the progress of the work here reported.

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8. QUIMBY, E. H., and STEWART, F. W. Comparison of various sources of interstitial radiation. *Radiology*, 1931, *17*, 449–470.

DISCUSSION

DR. MAX CUTLER, Chicago. Mrs. Quimby's studies are exceedingly important to the surgeon who attempts to distribute radium needles throughout a tumor mass. It is this line of research that has demonstrated the inadequacy of the radiation that was used in the older technique.

I should like to ask Mrs. Quimby, when she speaks of 5 erythema doses or 10 erythema doses, if that figure indicates the amount of radiation received by the entire tumor mass or that each unit received that quantity of radiation?

MRS. QUIMBY. It means that every point received that much and no point will receive less.

DR. CUTLER. That is very interesting, and I think highly important. Knowing the precise physical data, other factors require consideration. We must look upon a tumor mass as an unstable unit, some portions of which grow more rapidly than others. The central portion of a tumor mass, untreated, has a natural tendency to spontaneous necrosis. When a uniform irradiation is applied to a tumor mass, the center of which is necrotic, a dose that is large enough to sterilize the periphery may result in overirradiation of the center with consequent ulceration.

I have applied this principle in actual practice and find it highly important to avoid overirradiation of the center of necrotic and semi-necrotic tumor masses. Now that Mrs. Quimby has supplied the important physical data a correct distribution of radium foci within tumors will be greatly facilitated.

DR. ALBERT SOILAND, Los Angeles. It is difficult for one who is not a physicist to discuss intelligently some of the points on the work with which Mrs. Quimby has so graphically presented us. I am very glad she brought up the question of implantation of radium needles in the breast, for that is the work which we ourselves are intensely interested in. Drs. Costolow and Meland, my clinical associates, and I have been engaged in this type of work for several years. I realize that our present technique is amenable to much improvement. It is impossible to insert radium needles in every portion of the breast and expose all parts to equal irradiation without endangering some structures, such as important veins, blood vessels, and sometimes the bone periosteum.

I wonder if Mrs. Quimby will explain the implantation technique as carried out at the Memorial Hospital. I feel that the insertion of radium needles is a distinct advance, but the

mechanical part of the work must be planned as carefully and carried out as thoroughly as the surgical. We have learned that every portion of the breast must be treated as well as that part involved in the tumor.

Dr. L. R. Sante, St. Louis. We have used the grid method in treating a number of tumors by the use of gold emanation tubes of varying lengths. These are threaded through lumbar puncture needles, placed parallel at 1.5 to 2 cm. distance. After the emanation tube is slid into place the lumbar puncture needles are withdrawn. A projecting eye is made on the end of the gold emanation tube, which serves to withdraw it. The question came up of the overirradiation of the center of the lesion and the diminishing amount of irradiation at the periphery. I do not see why this factor could not be overcome by using weaker tubes in the center of the growth and varying strengths as we approach the periphery. If this were done it would give a greater degree of homogeneous irradiation than we could otherwise get. This is not a waste of radon since as soon as the tubes become weak we can cut them up and use them as seeds. In the tumors of the breast or in the neck where you can go through from one side to the other it seems to me this method is well worth developing.

Mrs. Quimby (*closing*). Dr. Cutler has emphasized a point which must always be remembered in dealing with interstitial irradiation; it is impossible to deliver homogeneous irradiation throughout a mass. There will always be great differences between the doses delivered at points a few millimeters from a needle and points farther away. In the material presented in this paper, I have been dealing with the *minimum* dose delivered within a specified region. From the clinical standpoint, this is the important dose, for it is the one which determines whether *all* the malignant tissue has been destroyed.

In cases where it is considered desirable that the minimum dose delivered on the periphery shall be greater than the dose within the mass, this can be accomplished by proper arrangement of the needles, as discussed in the paper.

I am not specifying the dose which should be used in any given case; this is the function of the clinician. But when he has decided on his dose, the information contained in this paper will enable him to deliver it most efficiently with the radium at his command.

What Dr. Soiland says about placement is important. The needles must be placed in the specified positions or the dosage tables are worse than useless—they are misleading. Of course, exact placing of the needles within a mass of tissue is difficult or impossible. What I am trying to bring out is that the greatest possible care must be exercised in implanting the needles, and then it must be remembered that the dosage tables offer a good approximation to the dose (not an absolute evaluation of it).

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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19th Annual Meeting: Cleveland, June 10–11, 1934.

EDITORIALS

CALCIFICATION OF THE SUPRARENAL GLANDS IN ADDISON'S DISEASE

IT HAS been eight-five years since Addison first described the clinical syndrome which now bears his name. The disease is a relatively rare one but it occurs with sufficient frequency to warrant the roentgenologist's being familiar with its clinical manifestations, primarily because of its rarity, and secondarily because of the possibility of the roentgen ray being of considerable assistance in its differential diagnosis. Addison, in his original monograph, reported eleven cases in which necropsy revealed definite pathological changes in the suprarenal capsules, such as "mottled with tuberculosis," "of a scrofulous nature," "cancerous deposit," and "exceedingly small and atrophied glands." In the description of his first case Addison reported: "The suprarenal capsules were diseased on both sides, the left about the size of a hen's egg, with the head of the pancreas firmly tied down to it by adhesions." The capsules were "as hard as stones." Ball, Greene, Camp and Rowntree[1] say that the accuracy of these observations of the pathological changes which serve as etiologic factors in Addison's disease is borne out by present-day investigations, and had the roentgen ray been available in Addison's time, no doubt he would have described roentgenographic changes in his first case.

The first case of Addison's disease in which the roentgen ray was useful in the diagnosis was reported by Rolleston and Boyd[2] in 1914, the case having been examined roentgenographically by Melville in which his findings were: "There are very definite calcareous particles in the region of the last rib and suprarenal body on the right side, less definite on the left . . .", and there does not seem to be any further reference to similar cases until 1928.

The recurrent frequency of calcification in the suprarenal glands in Addison's disease, together with the knowledge of the case reported by Rolleston and Boyd, stimulated Camp, Ball and Greene[3] to make a thorough investigation of the cases which they had observed at the Mayo Clinic. This investigation had as its object, first, the determining the incidence of calcification in a series of isolated suprarenal glands removed at necropsy in cases of Addison's disease, and second, determining the incidence of calcification in the suprarenal areas in a consecutive series of cases of Addison's disease. In the roentgenograms of the group of suprarenal glands in which pathological changes were found at necropsy, three types of calcification were recognized: (1) gross calcification of the entire gland; (2) multiple discrete areas of calcification throughout the gland, and (3) homogeneous increased density of the whole gland suggesting a diffuse deposition of lime salts such as might be expected with a high grade of caseation. The high incidence of calcification demonstrated roentgenographically in the series of isolated glands studied immediately raised the question of its roentgenological demonstration in life. Up to the time that Camp, Ball, Greene and Rowntree made their studies a review of the literature revealed that six cases had been reported in which

[1] Ball, R. G., Greene, C. H., Camp, J. D., and Rowntree, L. G. Calcification in tuberculosis of the suprarenal glands; roentgenographic study in Addison's disease. *J. Am. M. Ass.*, 1932, *98*, 954–961.

[2] Rolleston and Boyd. Quoted by Payne.

[3] Camp, J. D., Ball, R. G., and Greene, C. H. Calcification of the suprarenal glands in Addison's disease. AM. J. ROENTGENOL. & RAD. THERAPY, 1932, *28*, 594–597.

shadows in the suprarenal region had been demonstrated by roentgen examination. This was a relatively small number of cases when the total number of cases of Addison's disease reported had been taken into consideration, and the relatively small number of cases demonstrated roentgenographically during life stimulated the thought that possibly by a more improved technique a higher percentage of calcified suprarenal glands in Addison's disease might be demonstrated roentgenographically. With this thought in mind, Camp, Ball and Greene, taking advantage of the improvements that have been made in technical equipment, began a more detailed study of those suspected cases of Addison's disease. After experimenting with various positions they arrived at the conclusion that an oblique view of the suprarenal region was necessary in order to minimize the superimposition of other shadows. The patient was therefore placed in a supine position on the roentgen table and for an exposure of the left gland the right side of the patient's body was raised to an angle of 30 degrees from the table and for an exposure of the right gland the left side was raised to an angle of 30 degrees from the horizontal, in each case the tube being centered vertically over the tip of the sternum, and they found that stereoscopic films were of considerable assistance. The conflicting shadows which might be confused with suprarenal gland calcification they found to be calcification in cartilage of the ribs, calcified mesenteric glands, atypical gallstones, calcified portions and stones in the upper pole of the kidney, calcification in the abdominal aorta and its branches, calcification in a paravertebral abscess, and calcification in an old perinephritic abscess. In order to obviate the confusion of these shadows they found it of advantage to take films both at inspiration and expiration. With this improvement in technique they were able to record a much higher incidence of calcification in the suprarenal glands than had been previously noted, and were able to establish a definite diagnosis in six cases.

More recently Payne[4] has reported three cases of Addison's disease in which the roentgen ray was of definite positive aid in the diagnosis.

Since the differential diagnosis of Addison's disease is sometimes difficult as it is not the sole cause of pigmentation of the skin, the use of the roentgen ray in the examination of suspected cases should not be overlooked as the demonstration of calcification in the region of the suprarenal glands in a doubtful case would be of considerable diagnostic importance.

[4] Payne, A. E. Three cases of Addison's disease radiographically confirmed. *Brit. J. Radiol.*, 1933, *6*, 747–750.

BURTON J. LEE
1874 - 1933

DR. BURTON JAMES LEE died at his home in New York City on November 12, 1933. The news of this sad event came as a great shock to friends and associates, many of whom had recently seen him in the enjoyment of vigorous health and the full pursuit of his very active life. Less than two weeks before he had been elected Chairman of the Committee on Malignancy of the College of Surgeons, and he was preparing to meet a full schedule of routine and special duties which he had recently assumed. Thus ended abruptly a career of high distinction and even greater promise.

Dr. Lee was born in New Haven, February 4, 1874, son of James Howard Lee and Susan Mary Hoyt Lee. He was graduated from Yale University in 1894 with the degree of Ph. B. and received his degree in medicine from the College of Physicians and Surgeons in 1898. His early training as a surgeon was obtained at Presbyterian Hospital, where he was intern and later Chief Surgeon of the Out-patient Department. Later he was attached to the Surgi-

cal service of the New York Hospital and was appointed Instructor of Surgical Pathology in Cornell University Medical College. In this period he was extremely active in the pursuit of problems in surgical pathology and especially in mammary gland pathology. Later he was made Professor of Clinical Surgery in Cornell.

He served in France from August 7, 1917, to January 25, 1919, attached to the Second Division with the rank of Lieutenant Colonel. He was the youngest consulting surgeon in the American Expeditionary Force. He had a distinguished war record due to his capacity for quick decision and effective action. On one occasion especially he took the lead in providing, under the most difficult circumstances, for the quick reception and care of a large number of wounded. He was decorated with the American Distinguished Service Medal and with the French Croix de Guerre.

Dr. Lee's main work was in the field of cancer at the Memorial Hospital in New York City where he was Attending Surgeon for thirteen years and Clinical Director since 1930. In 1920, at a time when he had an established position and an assured future in general surgery he made the crucial decision to abandon the general field and devote himself exclusively to cancer. From that time forward he engaged with great energy and high intelligence in the development of cancer service and in the general problems of cancer control. His services to the Memorial Hospital were of outstanding importance to that institution. He introduced into the Hospital a modern and thorough system of clinical records, developed a corps of expert record clerks, and made the use of accurate records a prominent feature of the daily routine, so that this Hospital is now in possession of many thousands of records which are indispensable in the clinical study of cancer, and which have formed the basis of many important clinical contributions.

At the same time he established the Social Service Department, securing the services of a group of able women, who provided the means and conducted the work of following up the fate of all cases, securing financial aid for indigent patients and their families, and properly caring for advanced cases. It would be impossible to overestimate the importance of this agency as a scientific and humanitarian function.

Dr. Lee elected the field of mammary diseases as his special department, for which he was eminently fitted by previous studies in mammary gland pathology. He soon developed a large service in mammary cancer, having regularly more than a thouand cases under treatment and observation. From this material he and his staff contributed many important communications on causation, diagnosis, and treatment. In the treatment of mammary cancer Dr. Lee maintained a strictly surgical attitude, holding the radical operation as the main reliance; but about this he developed radiation therapy as an adjuvant to surgery, subdividing his cases in accordance with clinical and pathological features, treating some by conservative measures, some by irradiation, and refusing to operate on many which he regarded as unfavorable. In this very difficult field he was cautious, practical, and progressive. His contributions on the treatment of mammary cancer by radiation attracted wide attention and strongly influenced current views on this subject. In the treatment of primary operable cases by radiation alone he went as far as a conservative surgeon, dealing with all classes of patients, may safely go at the present time, and he had a substantial list of such cases clinically well from five to ten years and an increasing list of more recent favorable cases. Most of these presented some contraindication to radical surgical measures.

In 1930 he was made Clinical Director of the Memorial Hospital, and in this position his talent for leadership became outstanding. He was always courteous, considerate and helpful to his colleagues and staff, and was thus able to inspire in the whole hospital a fine spirit of loyalty and

cooperation. He placed a high value upon the work of the hospital in undergraduate and postgraduate instruction in cancer, and it was largely due to his constant attention that the present system of clinical fellowships has proved highly successful.

Dr. Lee engaged very actively in the work of several organizations devoted to the general problems of cancer control. He was Chairman of the Committee on Malignancy of the American College of Surgeons, and in 1931 at the request of the College made an extensive tour of the South and West delivering lectures and urging the establishment of cancer clinics in hospitals. He responded to other very numerous calls for lectures and demonstrations on many phases of cancer control, which told heavily on his physical resources. He was Chairman of the Executive Committee of the American Society for Cancer Control and exerted a strong influence on the work of that organization. In 1933 he was President of the American Radium Society. All these activities were the expression of his deep interest in the cancer problem and his conception of his responsibilities as Clinical Director of a cancer institute.

Dr. Lee's main personal characteristics were untiring industry, courtesy, cheerfulness, and friendliness. Softened by these fortunate traits, which never lapsed, his demands for a high standard of efficiency were cordially met. His strong optimism enabled him to accomplish many difficult projects which others avoided. He was a generous and loyal friend. One of his recent acts was the establishment of the Janeway Lectureship of the American Radium Society, in honor of the late Dr. H. H. Janeway, who from 1916 to 1921 was the first Clinical Director of the Memorial Hospital.

There is no doubt that his strenuous exertions of the past several years told more heavily on his physical strength than he was willing to acknowledge. In 1929 he underwent an operation for bilateral cataract, but he allowed this serious misfortune to interrupt his work for only a few weeks. In August, 1933, he received the first sharp warning, but after a brief rest he elected to continue work at a slightly reduced pace, fully aware of the probable course and termination of coronary thrombosis. A very painful terminal illness he met with splendid and unflinching courage and without complaint.

The death of Dr. Burton J. Lee removes from the ranks of American Surgery a distinguished and colorful personality, cancer control in America loses a forceful and devoted exponent, while the Memorial Hospital suffers the irreparable loss of his most capable direction and enthusiastic support.

James Ewing

RESOLUTION OF THE NEW YORK ROENTGEN SOCIETY

In the untimely death of Dr. Burton James Lee on November 12, 1933, at the age of fifty-nine, the medical profession has lost one of its outstanding members. The privilege of recounting the achievements of Dr. Lee has been entrusted to Dr. James Ewing; the New York Roentgen Society desires to add this brief memorial of its own regret at the passing of one whose conspicuous ability in surgery was supplemented by an equally unusual knowledge of radiation therapy, all combined with an almost unique interest in the humanities of medicine. No patient or former pupil of Dr. Lee could fail to remember him as an unfailing friend.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. E. P. Pendergrass, University Hospital, Philadelphia, Pa.
Annual Meeting: Pittsburgh, Pa., Sept. 25–28, 1934.

AMERICAN COLLEGE OF RADIOLOGY
Secretary, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif.
Annual meeting: Cleveland, 1934.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio.
Annual meeting: Cleveland, Ohio, June 11–15, 1934.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N.Y.
Annual meeting: 1934, to be announced.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY
Secretary, Dr. W. B. Firor, 1100 N. Charles St., Baltimore.
Meets third Tuesday in each month from September to May.

RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL SOCIETY
Secretary, Dr. R. T. Taylor, Los Angeles, Calif.
Meets on the third Wednesday of each month at the California Hospital.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. F. B. Bogart, Medical Arts Bldg., Chattanooga, Tenn.
Annual meeting: San Antonio, Texas, November, 1934.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. G. W. Cramp, 921 President St., Brooklyn, N.Y.
Meets monthly on first Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N.Y.
Meets second Monday of each month except during summer months, place of meeting selected by the host.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. R. G. Willy, 1138 N. Leavitt.
Meets second Thursday of each month October to May inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. H. G. Reineke, Christian R. Holmes Hospital, Cincinnati, Ohio.
Meetings held monthly.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. Otto Glasser, Cleveland Clinic.
Meetings are held at 6:30 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. E. R. Witwer, Harper Hospital.
Meets monthly on first Thursday from October to May, at Wayne Country Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY
Secretary, Dr. W. McL. Shaw, 418 St. James Bldg., Jacksonville, Fla.
Meetings held twice a year, May and November.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. H. W. Grote, 219 N. Main St., Bloomington, Ill.
Regular meetings held quarterly.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. J. N. Collins, Indianapolis, Ind.
Annual meeting each February 22 in Indianapolis.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
Secretary, Dr. S. W. Donaldson, St. Joseph's Mercy Hospital, Ann Arbor, Mich. Three meetings a year, Fall, Winter, and Spring. Next meeting, Detroit, Mich., February, 1934.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee, Wis.
Meets first Friday in October, December, February, and April. Place of meeting designated by the president.

MINNESOTA RADIOLOGICAL SOCIETY
Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. C. W. Schwartz, 33 E. 68th St., New York.
Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA ROENTGEN RAY SOCIETY
Secretary, Dr. Major Fleming, Rocky Mount, N.C.
Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. F. C. Rulison, Medical Arts Bldg., Syracuse, N.Y.
Three meetings a year—January, May, and November.

PACIFIC ROENTGEN CLUB
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif.
Meets annually, during meeting of California Medical Association

PENNSYLVANIA RADIOLOGICAL SOCIETY
Secretary, Dr. W. E. Reiley, Clearfield, Pa.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. Karl Kornblum, Graduate Hospital.
Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N.Y.
Secretary, Dr. W. W. Fray, Strong Memorial Hospital.
Meets monthly on second Thursday from October to May, inclusive, at 7:45 at the Rochester Medical Association Building.

ST. LOUIS ROENTGEN CLUB
Secretary, Dr. W. K. Mueller, University Club Bldg.
Meets first week of each month. Time and place of meetings designated by president.

SOUTH CAROLINA X-RAY SOCIETY
Secretary, Dr. R. B. Taft, 105 Rutledge Ave., Charleston.
Meets at time and place of South Carolina State Medical Association.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Texas Radiological Society
Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas.
Meets annually one day preceding the meeting of the Texas State Medical Association.

University of Michigan Roentgen Ray Society
Secretary, Dr. C. C. Taylor, University Hospital, Ann Arbor, Mich.
Meets first and third Wednesday evening of the month from October to June, at 8 o'clock in the amphitheatre of the University Hospital.

University of Wisconsin Roentgen Club
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis.
Meets monthly on last Thursday, October to April, Service Memorial Institute, at 4:30 p.m.

Virginia Roentgen Ray Club
Secretary, Dr. V. W. Archer, University Hospital, University, Va.
Meets annually in October.

Cuba

Sociedad Cubana de Radiologia y Fisioterapia
Secretary, Dr. Luis Fariñas, Animas 110, Havana, Cuba.
Meets monthly in Havana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 p.m., at 32 Welbeck St., London, W. 1., or as advertised.

Electro-Therapeutic Section of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month during the winter at 8:30 p.m. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

Section of Radiology and Medical Electricity, Australasian Medical Congress
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

Section on Radiology, Canadian Medical Association
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

Indian Radiological Association
Secretary, Sd. Subodh Mitra, 148 Russa Rd., Calcutta.
Meets annually in January, and at such places and times as the Council may appoint.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

Continental Europe

Belgian Society of Roentgenology
Secretary, Dr. J. Boine, Avenue des Allies, 134, Louvain, (Belgian).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summer time.

Société de Radiologie Médicale de France
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

Société Française d'Electrothérapie et de Radiologie Médicale
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Association of German Roentgenologists and Radiologists in Czecho-Slovakia
Secretary, Dr. Walter Altschul, German University, Prague, 11/52.

Deutsche Röntgen-Gesellschaft (Gesellschaft für Röntgenkunde und Strahlenforschung)
Meets annually in April in different German cities, at least once in five years in Berlin. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent Secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

Dutch Society of Electrology and Roentgenology
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

Societa Italiana Radiologia Medica
Secretary, Professor M. Ponzio, University of Turin, Turin.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banul Maracine 30, Bucharest, Rumania.
Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad, USSR, in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

Polish Society of Radiology
Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw.
Meets annually.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summer time.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summer time.

Society of Medical Radiology of Sweden
Meets in Stockholm.

Society of Medical Radiology in Norway
Meets in Oslo.

Society of Medical Radiology in Denmark
Secretary, Dr. H. Scheuermann, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

Society of Medical Radiology in Finland
Meets in Helsingfors.

Vienna Society of Roentgenology
Meets first Tuesday each month, October to July.

Orient

Japan X-Ray Association
c/o Orthopedic Surgery, Tokyo Imperial University
Meets annually in April.

Kinki Roentgen-Abend Society
Director, Dr. Prof. Taiga Saito, Ogawaoike, Kyoto, Japan.
Meets bi-monthly on third Sunday.

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers as space permits.

THE 1933 YEAR BOOK OF RADIOLOGY. Diagnosis, edited by Charles A. Waters, M.D., Associate in Roentgenology Johns Hopkins University; Assistant Visiting Roentgenologist, Johns Hopkins Hospital; Therapeutics, edited by Ira I. Kaplan, B.Sc., M.D., Director, Division of Cancer, Department of Hospitals, City of New York; Visiting Radiation Therapist, Bellevue Hospital, etc. Cloth. Price, $7.00. Pp. 804, with 780 illustrations. Chicago: The Year Book Publishers, Inc., 1933.

Those who inspected or purchased the Waters and Kaplan Year Book of Radiology for 1932 need only be informed that the 1933 volume is ready, for they will certainly not wish to be without the second volume.

The satisfactory general arrangement previously used is again followed, i.e., with the various anatomical systems treated first in respect to roentgen diagnosis and then from the standpoint of roentgen and radium therapy. Again we find all important publications and many minor ones in many languages represented in the abstracts; to be exact, they number 125 publications from nineteen countries. The unusual and new is naturally predominant as it is in the literature in general. The wealth of interesting cases is surprising and the number of illustrations exceeds those of last year's book by three hundred.

As Dr. Waters states, a greater effort has been made to include more articles of general interest to make it more attractive to medical men in general. This should in no way lessen its appeal to radiologists, who, above all other specialists, must keep in touch with the newer developments in all fields of the profession. Many men keep up-to-date chiefly by reading the abstracts which are a feature of all leading journals. These are, however, much inferior in educational value to the carefully selected, well correlated, and profusely illustrated material in the Waters and Kaplan work. Nor do they have the benefit of the excellent critical comments with which these experienced radiologists enrich their collection.

If we could add but one volume to our roentgen library during the year we would unhesitatingly choose this one. We do not believe any radiologist, internist or surgeon can afford to be without it.

E. WALTER HALL

FUNCTIONAL DISORDERS OF THE LARGE INTESTINE AND THEIR TREATMENT. By Jacob Buckstein, M.D., Instructor in Gastrointestinal Roentgenology, Cornell University Medical College; Alimentary Tract Division, Roentgen Department, Bellevue Hospital, etc. Fabrikoid. Price, $3.00. Pp. 265, with 100 illustrations. New York and London: Harper and Brothers, 1932.

This monograph is a useful presentation of the present status of functional colonic disorders. The chapter headings are: Normal Colon, Causes of Constipation, Symptoms, Treatment of Constipation, Clinical Significance of Mobile Cecum, Enteroptosis, Differentiation of Pain of Right Colon Stasis, Functional Hypermotility of the Colon, Irritability of the Colon, Gaseous Distention of the Large Intestine, Megacolon.

Perhaps a little too much emphasis is placed on the earlier literature, and not enough on the more recent clinical roentgen studies. The presentation of anomalies of cecal descent particularly could be brought up to date.

Several individual errors may be mentioned. Possibly the most evident is the failure to use the proper Latin plural in such words as scybalum, diverticulum, haustrum (pp. 48, 75, 99). Foreign references are incorrectly spelled (pp. 51, 131, 150) and the name of Franz Glenard is misspelled twice on p. 136. The caption of Fig. 60, c, is incompletely copied from Stierlin, the time interval having been omitted.

The captions of some of the roentgenograms at the end of the book may be questioned. Thus in Plate VI the high position of the cecum is better explained by failure of descent, rather than of rotation. In Plates XVI and XVII the appearance ascribed to retrograde transport may perhaps be better explained by the emptying out of a faintly visible cecal residue between the twenty-four hour and the forty-eight hour

observation. Plate XXII is described as ileal stasis at twenty-four hours. From the fact that the patient suffered from migraine with vomiting it is quite possible that the stomach did not empty on time when this roentgen observation was made. In any event, the exact emptying time of the stomach should have been noted before a diagnosis of ileal stasis could have been made on a twenty-four hour film.

All in all, the above criticisms are minor and corrections can easily be made in a subsequent edition. The book may be safely recommended, for it fills a need as a ready source of reference for the specialist, and as a useful guide to diagnosis and treatment for the general practitioner.

JOHN L. KANTOR

DIAGNOSTICO DE LA APENDICITIS CRONICA. By Doctors F. Gallart Monés and T. A. Pinós, with a foreword by Juan Madinaveitia. From the Escuela de Patologia Digestiva del Hospital de la Santa Cruz y San Pablo de Barcelona (Director Prof. F. Gallart Monés). Paper. Price, 35 ptas. Pp. 282, with 165 illustrations. Barcelona: Salvat Editores, 1933.

As is pointed out by Madinaveitia in the foreword to this book, chronic appendicitis may be a lesion that is almost self-evident in some cases and so obscure in others that extensive investigation of the patient by many methods of examination may be necessary to demonstrate its presence. Gallart Monés and Pinós consider the value of the best clinical and laboratory methods of examination and emphasize especially the importance of roentgen examination in conjunction with other methods of arriving at a correct preoperative diagnosis. First (pages 1–5) the authors consider in some detail the importance of the diagnosis of chronic appendicitis and next discuss briefly the histologic (pages 9–16) and clinical (pages 17–30) aspects of the lesion. The roentgen findings which may lead to an accurate diagnosis are illustrated by excellent reproductions of typical roentgenograms (supplemented by explanatory sketches) and are amplified by reports of clinical cases (pages 32–140). In this portion of the monograph the importance of the direct and indirect roentgenologic signs of appendicitis are conservatively evaluated. The separation of appendicitis from coincidental and often confusing lesions, such as deformities or abnormal position of the vicera, is next considered (pages 173–277) and in this connection some of the more uncommon conditions of the appendix are described. An extensive bibliography closes the book.

The stock, the type, in fact the whole production of this book by the publishers leaves little to be desired. This monograph on the diagnosis of such a common and important disease deserves serious consideration by internists, surgeons and roentgenologists in order that diagnostic accuracy may be increased to the advantage of the patient.

A. U. DESJARDINS

PRÉCIS D'ÉLECTRO-RADIOLOGIE APPLIQUÉE À L'ODONTO-STOMATOLOGIE. By Docteur E. Pierron, Ex-Assistant d'Électro-Radiologie des Hôpitaux Boucicaut et Broussais; Professeur suppléant à l'École de Chirurgie dentaire et de Stomatologie de Paris. Préface du Docteur Paul Cottenot, Ex-Interne des Hôpitaux; Médecin Électro-radiologiste des Hôpitaux de Paris. Cloth. Price, 65 francs. Pp. 356, with 196 illustrations. Paris: L'Expansion Scientifique Française, 1933.

This very well published book is designed to present to dentists the theoretical, physical, biological and clinical aspects of the physical agents as they apply to their specialty. In the first section the author takes up general theories of electricity and their biological applications. The second part is concerned with the practical applications of electroradiology in odontostomatology and the technical aspects of it are reviewed critically. Iontophoresis, faradism, high frequency, hertzian waves, infra-red light, ultraviolet rays, roentgen rays, and radium are discussed, and their indications and limitations are outlined. The author wisely counsels that the therapeutic applications of radium and roentgen rays be left to specialists. The chapter on roentgen rays as a diagnostic medium discusses the fundamentals of technique necessary for a good roentgenogram and the criteria for the diagnosis of many intraoral normal and pathologic conditions. Accidents and pitfalls are emphasized in the next section. There then follows some well worthwhile advice on the choice of apparatus. A tabular view of the various intraoral lesions follows with the outline of the most effective modality for their treatment.

This simply presented yet quite complete book should be of inestimable value to dentists

and oral surgeons in that it gives concisely the indications and contraindications for the use of electroradiology. Furthermore, it offers to radiologists a new aspect of a field which is, unfortunately, generally neglected by them.

E. T. Leddy

Books Received

The Digestive Tract: A Radiological Study of its Anatomy, Physiology, and Pathology. By Alfred E. Barclay, O.B.E., M.A., M.D., D.M.R.E., Lecturer in Medical Radiology, University of Cambridge; Formerly Hon. Medical Officer in charge of the X-Ray Department, Manchester Royal Infirmary, and Lecturer in Clinical Radiology, University of Manchester. Cloth. Price, $12.00. Pp. 396, with 275 illustrations. Cambridge: The University Press; New York: The Macmillan Co., 1933.

Benign Tumors in the Third Ventricle of the Brain: Diagnosis and Treatment. By Walter E. Dandy, M.D., Adjunct Professor of Surgery, The Johns Hopkins University. Cloth. Price, $5.00. Pp. 171, with 120 illustrations and 4 tables. Springfield, Illinois; Baltimore, Maryland: Charles C Thomas, 1933.

The 1933 Year Book of Radiology. Diagnosis, edited by Charles A. Waters, M.D., Associate in Roentgenology, Johns Hopkins University; Assistant Visiting Roentgenologist, Johns Hopkins Hospital; Therapeutics, edited by Ira I. Kaplan, B.Sc., M.D., Director, Division of Cancer, Department of Hospitals, City of New York; Visiting Radiation Therapist, Bellevue Hospital, etc. Cloth. Price, $7.00. Pp. 804, with 780 illustrations. Chicago: The Year Book Publishers, Inc., 1933.

Nasal Accessory Sinuses. By Frederick M. Law, M.D. (*Annals of Roentgenology*, Vol. xv. Edited by James T. Case, M.D.) Cloth. Price, $10.00. Pp. 215, with 225 illustrations, New York: Paul B. Hoeber, Inc., 1933.

Wilhelm Conrad Röntgen and the Early History of the Roentgen Rays. By Otto Glasser, Cleveland Clinic Foundation. With a chapter, Personal Reminiscences of W. C. Röntgen, By Margret Boveri, Berlin. Cloth. Price, $6.00. Pp. 494, with 96 illustrations. Springfield, Illinois; Baltimore, Maryland: Charles C Thomas, 1934.

Neurology. By Roy R. Grinker, Associate Professor of Neurology, The University of Chicago. Cloth. Price, $8.50. Pp. 979, with 401 illustrations. Springfield, Illinois; Baltimore, Maryland: Charles C Thomas, 1934.

Functional Disorders of the Large Intestine and their Treatment. By Jacob Buckstein, M.D., Instructor in Gastrointestinal Roentgenology, Cornell University Medical College; Alimentary Tract Division, Roentgen Department, Bellevue Hospital, etc. Fabrikoid. Price, $3.00. Pp. 265, with 100 illustrations. New York and London: Harper and Brothers, 1932.

Radiodiagnostico en la infancia: tomo primero pelvis y extremidad inferior. By Manuel y Francisco Arce, Radiólogos del Hospital del Nino Jesús, Clínica de Pediatría de la Facultad de Medicina de Madrid y Asilo de San Rafael. Prólogo del Dr. D. Enrique Suñer, Catedratico de Pediatría de la Facultad de Medicina de Madrid. Primera edición. Pp. 285, with 210 illustrations. Madrid: Ediciones Boro, 1933.

Manuel de radiodiagnostic clinique. Par R. Ledoux-Lebard, Chargé de Cours de Radiologie Clinique a la Faculté de Médecine de Paris; Radiologiste des Hôpitaux. Volumes I and II. Cloth. Price, 250 fr. Pp. 1076, with 1143 illustrations. Paris: Masson et Cie, 1933.

Contribution a l'étude radiographique du sein normal et pathologique. By Dr. Alexandre Espaillat-G., de la Faculté de Médecine de Paris, Certificat d'Electro-Radiologie de la Faculté de Paris. Travail de la Clinique chirurgicale du Professeur Gosset et du Laboratoire de Radiologie clinique de la Faculté (Dr. Ledoux-Lebard, Chargé de cours). Paper. Pp. 154, with 18 illustrations. Paris: Librairie Louis Arnette, 1933.

Précis d'électro-radiologie appliquée a l'odonto-stomatologie. By Docteur E. Pierron, Ex-Assistant d'Électro-Radiologie des Hôpitaux Boucicaut et Broussais; Professeur suppléant à l'École de Chirurgie dentaire et de Stomatologie de Paris. Préface du Docteur Paul Cottenot, Ex-Interne des Hôpitaux; Médecin Électro-Radiologiste des Hôpitaux de Paris. Bound. Pp. 356, with 196 illustrations. Paris: L'Expansion Scientifique Française, 1933.

Grundlagen und Praxis der Röntgenstrahlendosierung: Dosismessung und Dosisfestsetzung. Von Prof. Dr. Med. H. Holthusen, Leitender Oberarzt am allgem. Krankenhaus St. Georg, Hamburg, gemeinsam mit Dr. Med. R. Braun, Assistent am Strahleninstitut des allgem. Krankenhauses St. Georg, Hamburg. Paper, price M. 18.—; bound, M. 19.60. Pp. 249, with 152 illustrations and 27 tables. Leipzig: Georg Thieme, 1933.

Die kombinierte Enzephal-arteriographie. Von W. Löhr und W. Jacobi. (*Fortschr. a. d. Geb. d. Röntgenstrahlen*, Erganzungsband 44. Herausgeber: Prof. Dr. Grashey.) Paper, price M. 16.—; bound, M. 18.—. Pp. 83, with 75 illustrations. Leipzig: Georg Thieme, 1933.

Reliefstudien an der normalen und krankhaft veränderten Speiserohre. (*Acta radiol.*, Suppl. xviii.) Von Richard Schatzki, S. Zt. Leiter des Röntgeninstitutes der medizinischen Universitätsklinik, Leipzig. Paper. Price, 20 Swed. Crowns. Pp. 149, with 159 illustrations. Stockholm: Alb. Bonniers Boktryckeri, 1933.

A Roentgenological Study of Acute and Chronic Otitis Media. (*Acta radiol.*, Suppl.

XVII.) By Gösta Runström, Med. Lic. Paper. Price, 20 Swed. Crowns. Pp. 90, with illustrations in the text and numerous separate plates. Stockholm: Acta radiologica, 1933.

HOMOGENEOUS X RADIATION AND LIVING TISSUES. By Warnford Moppett, M.D., Ch.M. (Sydney). Pp. 133, with 75 illustrations. Sydney: Australasian Medical Publishing Company, Ltd., 1932.

MEDICAL USES OF RADIUM: SUMMARY OF REPORTS FROM RESEARCH CENTRES FOR 1932. Medical Research Council, Special Report Series, No. 186. Paper. Price, 1s. Pp. 36, with 5 illustrations and numerous tables. London: His Majesty's Stationery Office, 1933.

MINNEAPOLIS GENERAL HOSPITAL, ANNUAL REPORT FOR THE YEAR 1932, PARTS I, II AND III.

DEPARTMENT OF TECHNIQUE

Department Editor: ROBERT B. TAFT, M.D., 105 Rutledge Ave., Charleston, S. C.

AN IMPROVED DEVICE FOR SYNCHRONIZING ROENTGENOGRAPHIC EXPOSURE WITH THE PATIENT'S PULSE*

By CHARLES WEYL, S. REID WARREN, JR., *and* D. B. O'NEILL
PHILADELPHIA, PENNSYLVANIA

IN 1925[1] there was described a pulse relay, activated by the carotid impulse, for causing the roentgenographic exposure of the chest to occur at a predetermined part of the heart cycle. In this apparatus a short air column, contained in a piece of rubber tubing and a cannula, transmitted the impulse from the carotid artery to a thin rubber diaphragm, which, by means of a lever system, caused the rotation of a small mirror. A beam of light was focused upon the mirror, so that rotation of the mirror caused angular displacement of the reflected beam. A photocell was so placed that the light was reflected into it by the mirror when the pulse compressed the air in the cannula and tube. The electrical impulse resulting from the incidence of light into the photocell was amplified by means of a thermionic system. This amplified impulse operated a mechanical device which introduced an adjustable known time lag into the operation. The lag timer, in turn, closed the roentgen-ray switch for making the exposure. Although the systolic action of the heart caused the operation of the pulse relay, the exposure to roentgen rays could be made at any predetermined time in the heart cycle by proper adjustment of the lag timer before operation. It was found that roentgenograms taken late in diastole showed the least distortion due to cardiac and vascular motion. There was the equally important advantage that two roentgenograms, taken in the manner called stereoscopic with the aid of the pulse relay, were observed to provide true stereoscopic effect, if the geometry of exposure and viewing was properly controlled.

The apparatus has been used at the Henry Phipps Institute for eight years. General use of the instrument has been impracticable because of several factors:

1. The operation of synchronization has required a great amount of technical skill attainable only by long practice.

2. The cost of the equipment was sufficiently high to preclude its purchase unless its real advantage was perceived.

3. Precise adjustment of the equipment was necessary at all times. Only by a careful study of the principles involved was it possible for one to learn to make these adjustments.

It is the consensus of opinion that in order to produce the best diagnostic roentgenograms of the thorax it is necessary that they should be synchronized. Therefore efforts were made to overcome the objections discussed above. As a result of intensive study and development a new pulse relay has been designed and thoroughly tested with which it is possible to make synchronized roentgenograms almost automatically. There follows a brief description of the principles of this new apparatus.

The carbon button of a microphone is used to convert the mechanical impulse of the carotid artery to an electrical impulse. Two mountings have been employed: one in which the microphone button is fixed in a small brass bell held by the technician to

* The apparatus described was designed and constructed at the Moore School of Electrical Engineering, University of Pennsylvania, under a grant by the National Tuberculosis Association.

[1] McPhedran, F. M., and Weyl, C. Automatic synchronization of roentgen-ray exposures. *Am. J. M. Sc.*, 1925, *169*, 510–516. U. S. Patent No. 1,688,675.

the neck of the patient; in the other the button is fixed in a leather band to be fastened about the patient's neck. In either case a *direct* mechanical connection between the movable terminal of the microphone and the skin of the patient provides for greatest efficiency. Connected in series with the microphone are a six-volt storage battery and a relay with adjustable sensitivity. A small current, insufficient to operate the relay, flows at all times. A slight pressure upon the movable terminal causes compression of the carbon granules within the button and consequent reduction of its resistance. The pressure therefore causes, indirectly, the flow of sufficient current through the relay for its operation. The system may be made so sensitive that the change in position of the button in air may cause the operation of the relay due to rearrangement of the carbon granules. However, such instability is completely eliminated by proper choice of relay resistance and proper adjustment of relay sensitivity by changing the position of its pole pieces or changing the tension of the spring which draws its armature to the release position. It is not necessary to use so strong a pulse as the carotid to operate the system. However, the use of the carotid is to be recommended because it follows, without important time lag, the heart action. The action of the system is extraordinarily stable and may be used easily by one without experience.

A lag timer has been designed to provide time lags from 1/60 second to 50/60 second in steps of 1/60 second. The timer is activated by 60-cycle supply current, in the manner to be described, and is therefore extremely constant in its operation. There are associated with the lag timer a number of relays for the purpose of making the operation of synchronization as automatic as possible.

A short description of the operation of the synchronizing device provides clearer understanding of its performance than a detailed analysis of the electrical circuit.

First, the microphone button is held in position over the carotid artery of the patient. Proper positioning results in the regular operation of the relay described above, at the beginning of each ventricular systole. Visual evidence of this regular impulse is provided by means of a small signal lamp which lights at each pulse. After the patient has taken a deep breath and the signal lamp shows regular operation of the pulsing mechanism, the technician closes a switch, by means of the foot or hand or knee as may be individually most convenient. This switch prepares the relay system in such fashion that the next succeeding pulse starts the lag timer. The switch is so arranged that, if it be operated at a time when the pulse relay is closed (that is, during systole) the lag timer is *not* operated until the beginning of the *next succeeding* systolic contraction. Therefore the technician is relieved of the responsibility of operating the foot switch between heart beats, a difficult procedure in any case and one practically impossible to perform if the pulse rate of the patient is greater than 90 per minute.

As has been mentioned, the closing of the foot switch prepares the system for complete operation by the next pulse. The lag timer, so introduced into the electric circuit, is constructed of a rotary switch blade and twenty-five contact points over which the blade travels. The blade is rotated magnetically in steps. Each pulse of current through its magnet advances the position of the switch blade one contact point. This magnet receives power from a half-wave rectifier system. Therefore the switch advances from one contact point to the next in 1/60 second, if the 110 volt, 60 cycle power supply system is used to operate the rectifier system. The rotary switch contacts are connected to a selector switch which is manually set to the time lag desired for any particular patient. By allowing for one-half, or for one revolution of the rotary switch, a range of time lags from 1/30 second to 25/30 second may be obtained. For any setting there may be a possible error of 1/60 second. This error is

negligible for the particular problem of chest roentgenography.

As the rotary switch passes over the contact representing the particular time lag chosen, the roentgen-ray timer is operated instantly and the roentgenographic exposure is made. A second signal lamp lights to show this operation.

When the foot switch is released after exposure the entire system prepares itself automatically for the next exposure. Therefore stereoscopic films may be made with no delay other than the usual time necessary for change of tube position and cassette.

The power supply system is designed to be connected to a 110 volt, 60 cycle lighting circuit. It is possible to construct a similar system for operation with 25 cycle power supply. The only necessary auxiliary equipment is a six-volt storage battery or four 1½-volt dry cells.

Provisions are made for calibration of the lag timer. Such calibrations, however, need not be made more than once in three or four months. Measurements show a constant probable error of about 1/50 second.

It is difficult to arrange for proper dissemination of detailed information concerning this device. It appears distinctly uneconomical to publish wiring diagrams and lists of material in a roentgenological journal. If those who are interested will write to the Moore School of Electrical Engineering, 200 South 33d Street, Philadelphia, a plan will be organized for submitting the pertinent data to them.

The authors wish to acknowledge the invaluable assistance of Mr. William Brandt, of the Automatic Electric Company, in the selection of proper relays for the system.

SOME TECHNICAL POINTS IN SINUS AND MASTOID ROENTGENOGRAPHY

By L. H. LEDBETTER, M.D.
BEAUMONT, TEXAS

IN THE practice of roentgenology often a simple suggestion from a fellow worker, some point he has learned by experience, has led us to improvement in our own work. With this thought in mind I am presenting here a method for making stereoscopic projections of both mastoid areas, or of the nasal accessory sinuses, on one film, and using the curved top Potter-Bucky diaphragm.

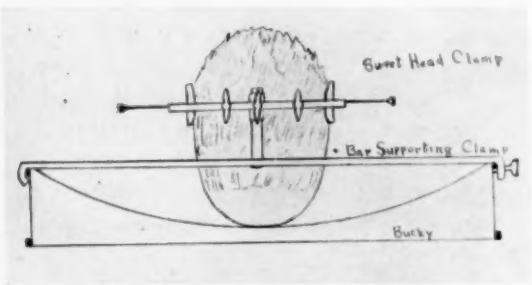

FIG. 1. Sketch of immobilizing device for sinus work.

A piece of sheet lead 56×56 cm.×1 mm. is used, with an oval opening 16×19 cm.

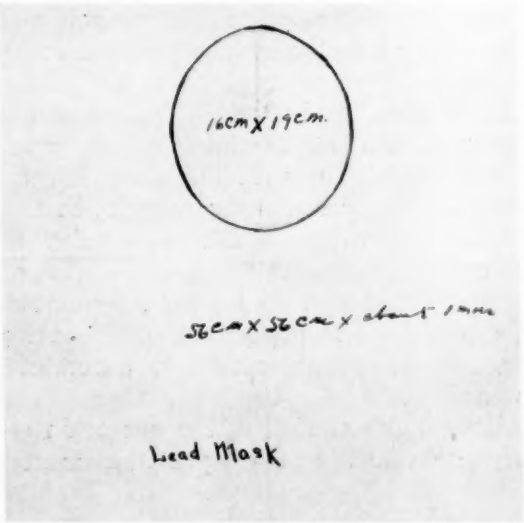

FIG. 2. Sketch of lead mask.

in its transverse center and about 3 cm. below its top margin, that is, the opening in the lead is in the center of its upper half. This lead mask is placed over the Potter-Bucky diaphragm, adapting itself to the curve of the top and in such position that the oval opening falls over the center of the cephalic half of the Potter-Bucky diaphragm. A 14″×17″ cassette is placed in the Potter-Bucky, the carriage tray or pan of which has been previously and permanently marked so that the opening in the lead falls over the center of the upper left quadrant of the film. Then with the patient prone, the right mastoid area is placed near the center of the opening in the lead and the head made stationary with a band or other immobilizing device. With the subject in this position, the head naturally rolls into the proper lateral angle so that only one tube tilt is necessary, a caudal tilt of 15° with the central ray emerging at about the tip of the process being filmed. Then the first exposure is made, and without disturbing the patient, the cassette is reversed, i.e., turned about, placing its hinged end at the cephalic end of the table

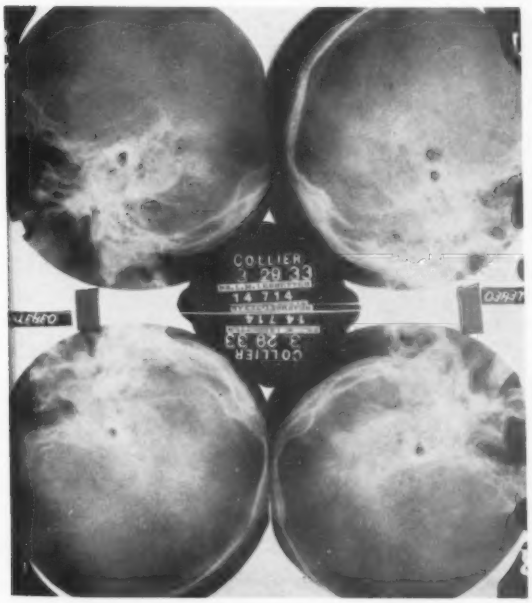

Fig. 3. Mastoid film for stereoscopic comparison before being bisected.

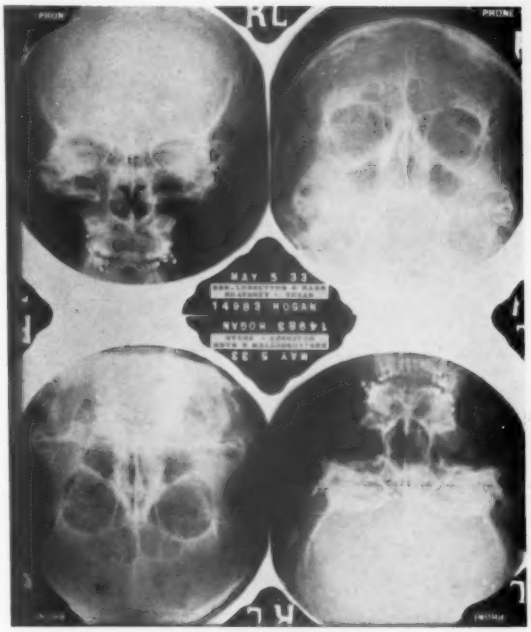

Fig. 4. Sinus film for stereoscopic study before bisecting.

but on the same mark as before, a lateral tube shift of 6.25 cm. is made and the second exposure made. The left mastoid area is now placed in position and the cassette is turned back to its first position, hinges toward the caudal end of table, but is placed farther over on the carriage tray to another predetermined mark so that the oval opening in the lead falls over its upper right quadrant; then the exposures, the cassette inverting, and tube shift as for the right are made for the left but using the No. 2 mark on the carriage tray for both of the left exposures.

The film when processed and dry is cut transversely at its center giving a right and a left mastoid area on each half in such a manner that when placed in the stereoscope they may be examined and compared stereoscopically without a change in position of the examiner or that of the film. In other words, a simultaneous stereoscopic comparison of the two mastoid areas is presented.

The same procedure is followed in sinus examinations, except that a vertical or

caudal cephalic tube shift is used instead of a lateral shift. If stereoscopic projections are made in all the four usual sinus positions then, of course, two films will be required. If the roentgenologist prefers the four sinus positions projected upon a flat

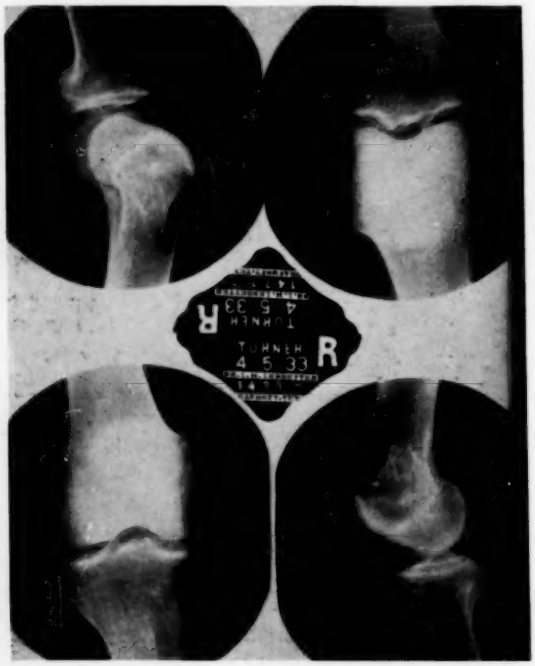

FIG. 5. Film showing application of the procedure to a study of the knee.

film, the procedure is varied so that the cassette is not inverted at any time. This is done so that all projections are in the upright when the film is viewed. To do this, however, the following procedure must be carried out: Two different positions are projected upon the upper or top half of the film by using the marks No. 1 and No. 2 on the carriage tray, then the lead is reversed and the patient slipped down on the table until in proper position for use of the caudal half of the Potter-Bucky; then the two remaining positions are projected upon the lower half of the film using marks No. 1 and No. 2 on the carriage as before. The result is four sinus positions on one flat film.

The 16×19 cm. oval opening in the lead gives ample area for any of these positions and at the same time leaves sufficient margin for marking films in any manner desired.

We mark films after all exposures are made. R. and L. are marked in their proper places in the margin, and in the center of the film between the four exposures, the patient's name, serial number and date of film are marked. In mastoid roentgenography this is done on each half of film so they may be properly identified after cutting.

For projecting the various sinus positions we arranged a simple and efficient immobilizing device in the following manner: We secured a section of steel bar or angle iron 4 cm. wide by 5 mm. thick and long enough so that each end could be turned down or crimped over the top edges of the curved Potter-Bucky and be slipped on and off at the end of the Potter-Bucky at will. Through one of the turned down ends was drilled a threaded hole and this fitted with a winged thumb bolt to secure the bar to the Potter-Bucky. Into the center of this bar is welded a round upright piece about 10 cm. long and of such a size that the curved head rest bar of an old Sweet localizer would fit upon it. With this arrangement and with the patient prone, the head may be effectively and comfortably fixed in all the usual sinus and mastoid positions.

There are a number of other cranial examinations to which the lead mask and the procedure described above lend themselves admirably. One is the stereoscopic examination of the ethmoids and antra in oblique projection with orbit-malar-nose contact. This film when finished presents a simultaneous stereoscopic study of the two sides. Another is the examination and measurement of the optic foramina. In this examination the patient is prone with orbit-malar-nose contact and the central ray projected so as to enter the vault at a point on the opposite side just anterior to the lambdoid suture and about 1 cm. below a line connecting the superior orbital margin and the lambda. The point of emergence

of the central ray should, of course, be the optic foramen of the orbit being examined.

The lead mask may also be used and the same procedure followed in making stereoscopic study of the ankle or knee, giving, on the finished film when bisected transversely, a simultaneous stereoscopic view of the part in both anteroposterior and lateral projections. This is a decided advantage since a stereoscopic study of joints is far superior to the flat film examination. This is especially true in healed or healing injuries involving the joint and in joint pathology where a critical study of the joint surface detail is essential for an accurate diagnosis.

A RADIUM NEEDLE CARRIER*

By HILDA LEE GOLTZ
BUFFALO, NEW YORK

WITH the increased interest manifested in interstitial irradiation and the accompanying increase in the use of radium needles, a need has arisen for a needle carrier which will facilitate handling, prevent confusion and afford as much protection as possible to the operator.

The needle carrier, designed for use in the State Institute for the Study of Malignant Disease, is shown in Figure 1. It consists of a block of brass covered lead, 4 × 2½ × 2 inches fastened to a brass plate, 4 inches wide, the ends of which are bent at right angles 4 inches from the middle so that the edges of the plate are level with the top of the block. The edges of the plate are cut so as to make ten pegs on each end, over which the wires or threads may be drawn to prevent tangling.

FIG. 1. The radium needle carrier. Note lead seals at end of wires, on which is impressed a number indicating the strength of the cells used in that needle.

FIG. 2.

For our purposes, since we have needles designed to hold one, two, or three cells,

* From the State Institute for the Study of Malignant Disease, Buffalo, New York. (Burton T. Simpson, Director.)

and the length of these needles varies, we have three carriers, differing only in the height of the lead block. In other words, the carrier for the one-celled needles has a block 1 inch high, the two-celled needle carrier has a block $1\frac{3}{4}$ inches high and the one for three-celled needles, a block $2\frac{1}{2}$ inches high.

Two rows of ten holes each, deep enough to permit only the inactive eye of the needle to project, are drilled in the block, 1 inch from either margin. A handle attached on the sides of the block may be made to lie flat against the brass plate. In this way the piece of apparatus occupies a space $4\times2\times8$ inches, small enough to be placed in any ordinary boiling water sterilizer. If the needles are to be delivered at some distance from the place where they are assembled, a second detachable handle 2 feet long, and supplied with a lead shield, may be screwed into the center of the block, (Fig.2) when the attached handle is in the horizontal position. After sterilization, when ready to insert, the needles may be grasped by the insertion forceps directly from the carrier without danger of pinching or breaking the wire or thread (Fig. 1).

The advantages of this type of carrier are: (1) The needles may be made up, threaded, transported, sterilized, and inserted with the minimum of handling. (2) The threads or wires do not become tangled, but are easily slipped off the peg when ready to insert. (3) The whole apparatus may be easily sterilized in an ordinary boiling water sterilizer. (4) The weight is a convenient one to carry. (5) The apparatus furnishes ample protection while the needles are being threaded and transported.

THE FILING OF LANTERN SLIDES

By CHARLES G. SUTHERLAND, M.D.
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IN THE segregation of interesting cases for teaching and for use in discussion before scientific societies, one collects, in the course of time, a considerable number of lantern slides. The filing of these in a manner that makes them easily available for study and for selection of individual slides covering certain points in any given discourse presents additional problems as the collection grows. The ideal method is one which will permit review of a large series of slides with the expenditure of a minimum of time and effort, and the refiling of the slides that they may more or less automatically fall into allotted places in the filing system.

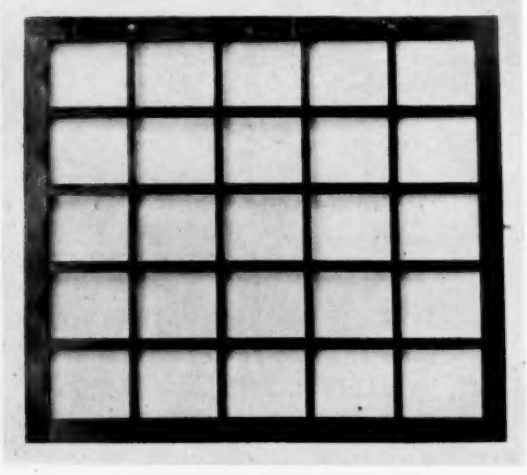

FIG. 1. Individual rack for twenty-five slides.

Several years ago, in an attempt to catalogue and segregate all the lantern slides of The Mayo Clinic, a rack was devised to hold twenty-five slides (Fig. 1) and a view box was provided that would hold two of these racks at one time, allowing the inspection of fifty slides simultaneously. Various methods of storing these racks were tried, with convenience of access and the minimum of space requirements as the main objective. The individual racks are 22 by $19\frac{1}{2}$ by 5/16 inches (56 by 49.5 by 0.9

cm.) spaced to hold five rows of five slides each. The lower margin of the slot on each row anteriorly is cut sufficiently so that the individual slide will slip into the upper slot and clear the lower to drop into position in the rack and be retained there. This allows the individual slides to be taken from when necessary. The inner rear wall is painted white to act as a reflector and there is a space of 2 inches (5 cm.) between the rear wall and the two anterior opal glass plates. Anterior to and above and below the troughs for the glass plates, metal slots have been provided to hold the

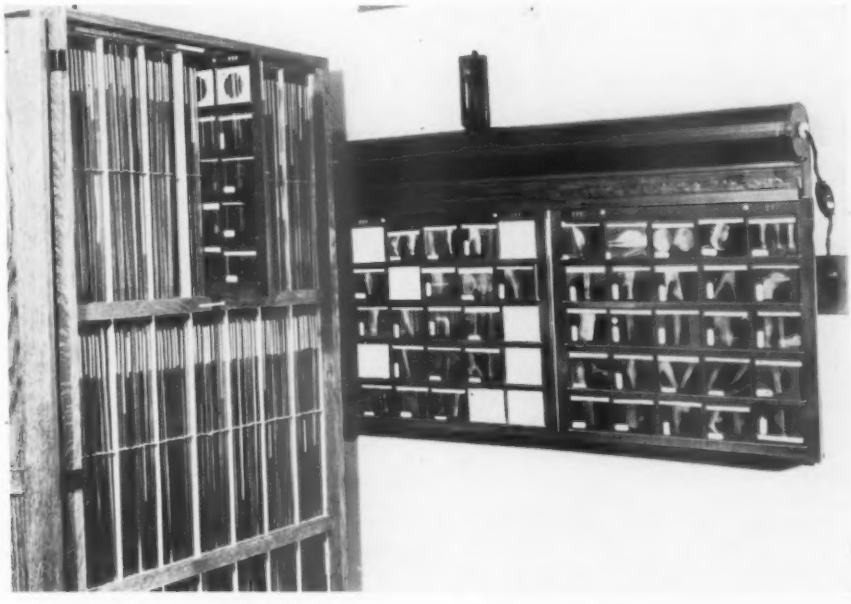

Fig. 2. Composite unit for lantern slides.

and replaced in the rack without disturbing the other slides. A small steel screw-eye conveniently placed on the anterior border acts as a handle to pull out any desired rack. It was found that ten racks (250 slides) would fit into a compartment 4 inches (10.2 cm.) wide and units of four or more compartments were made up to suit the office space available. The front border of the rack affords more than 20 inches (50 cm.) for legends. These are typed, cut and pasted on the wood and can be covered with transparent cellophane tape to avoid soiling. A view box 44 by 26½ by 4½ inches (115 by 67 by 12 cm.) to hang on the wall convenient to the cabinet was manufactured from sheet metal; the lighting bulbs are in a cylinder on the top of the view box, the anterior two-thirds of the cylinder being hinged to provide access to the bulbs racks. The upper slot has a depth of 7/8 inches (2.4 cm.) and the lower one of 3/8 inches (1 cm.) so that the racks may be slipped into the upper slot to clear the lower margin of the aperture, and dropped back into the lower slot. By this method the individual racks can be put in and taken out without disturbing the second rack.

This method of filing lantern slides appeared to offer many advantages, and I forwarded the details to one of the manufacturers* of sectional office furniture and asked if these units could be made up with doors similar to those of sectional book cases. They replied that this could be done. A unit to hold 1,000 slides would occupy approximately 20 by 22 by 24 inches and allow distribution and segregation of various groups to make them available quickly

* The Macey Company, Grand Rapids, Michigan.

and conveniently. Through combinations of units the housing of larger collections of slides may be accommodated to any available office space. In my office a collection of 5,250 slides (Fig. 2) occupies only 24 by 31 inches of floor space to a height of 67 inches. The rows of the individual racks can be numbered and the spaces lettered and notations corresponding to these can be put on the individual slides so that they may be returned to their proper places by any person of average intelligence. Cards cut to the dimensions of a lantern slide may be kept in a pocket on the side of the cabinet; when slides are loaned a note can be made on the card of the subject, the case number and the name of the borrower and this card placed in the space occupied by the slide stands as a record against the borrower. When the slide is returned, the card can be discarded. Requests for slides depicting any given subject are met with the minimum expenditure of time and effort.

My experience with this type of filing cabinet has prompted me to publish this for the benefit of those to whom the lantern slide has become a problem.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

ABDOMEN

Buisson, Paolo. Sull'interpretazione dei reperti colecistografici. (Interpretation of cholecystographic findings.) *Radiol. med.*, Sept., 1932, *19*, 996–1030.

The author believes that when intravenous cholecystography shows little or no opacity of the gallbladder it means that there is disease of the liver or bile tract. He disagrees with those authors who say that these pictures may be caused by disease outside the biliary tract, such as ulcers of the stomach and duodenum, chronic appendicitis, diseases of the genito-urinary tract, anemia, diabetes, Basedow's disease, etc. He presents arguments against the theories advanced by these authors in support of their contention. He thinks their opinion is based on errors due to defective methods of examination, particularly oral cholecystography, to failures on the part of the patients to follow directions, poor roentgen technique, etc. Or if the pictures were really negative there was some disease of the bile tract that was not discovered by the surgeon on operation as it was masked by the other disease, or, still more probably, there were unsuspected disturbances of liver function.—*Audrey G. Morgan.*

Pellini, Maria. L'importanza dell'indagine colecistografica nella diagnosi delle colecistopatie. (The importance of cholecystographic examination in the diagnosis of gallbladder disease.) *Radiol. med.*, March, 1932, *19*, 215–296.

The importance of cholecystographic examination in disease of the gallbladder should be neither overexaggerated nor denied. It varies greatly in different pathological conditions and in different cases. As in other conditions there must be close cooperation between clinician and roentgenologist in order to get good results.

The author discusses his results in 100 cases. He concludes that the best way to give the opaque medium is by mouth, using Sandström's fractional dosage. The examination is not complete if it does not include a study of the motility of the gallbladder by giving the standard meal of three egg yolks and following up the evacuation of the gallbladder by series of roentgenograms.

He finds that a very opaque shadow does not necessarily mean that the gallbladder is normal anatomically but simply means that it has a good capacity for concentration; on the other hand, a slight shadow does not necessarily mean that the capacity for concentration is not good and it does not have any pathological significance unless it is accompanied by other symptoms. Pribram and others have even found a pale shadow in cases with increased capacity for concentration in acute inflammation of the gallbladder. A pale shadow as well as an opaque one shows that the cystic duct is permeable; so there is a great deal of difference between that and the case in which there is no shadow at all. A negative finding does not always mean the same thing. Providing the technique is good and there are no serious changes in the liver it may indicate occlusion of the cystic duct, obliteration of the gallbladder cavity by stones or a diffuse change in the wall of the gallbladder. Or it may even be caused by changes in other organs, such as the stomach, duodenum or appendix.—*Audrey G. Morgan.*

Lönnerblad, Lars. Fälle von spontaner innerer Gallenfisteln. (Cases of spontaneous internal bile fistula.) *Acta radiol.*, 1932, *13*, 551–566.

The author reviews about 40 cases of internal bile fistula previously described in the literature which have been diagnosed by roentgen examination and then describes 2 cases of his own.

The first was one of fistula between the colon and gallbladder in a man of seventy-two who came for treatment for diarrhea and boring pain in the epigastrium. The chief roentgen finding was the fistula between the colon and the gallbladder. The patient improved on the ordinary diet for colitis and was discharged free of symptoms. In view of his age and the slight symptoms it was not thought advisable to perform radical operation for the fistula. It had evidently been caused by cholecystitis and cholelithiasis which however had remained latent.

The second was a case of ulcer of the duo-

denum which had perforated into the common duct in a farmer thirty-five years of age who came for treatment for constant pain in the epigastrium radiating to the back, and vomiting at times. A Billroth II resection of the stomach was performed and the fistula left as it was. The patient was discharged free of symptoms.

These fistulas are easily diagnosed by roentgen examination. There is rarely any difficulty in differential diagnosis from ulcer, diverticulum or abscess.—*Audrey G. Morgan.*

ARNTZEN, LEIF. Penetration of contrast meal substance from the duodenum into the bile passages via the ductus choledochus. *Acta radiol.*, Aug. 15, 1932, *13*, 202–204.

A case is described in a woman sixty-one years of age in which part of the barium meal that was given entered the common and hepatic ducts and their branches but neither the cystic duct nor the gallbladder was filled. Roentgenograms are given which would indicate that the barium may have passed into the common duct by way of Vater's papilla but the history indicates that there was a fistula close to the opening of the common duct into the duodenum.—*Audrey G. Morgan.*

MUZII, MARIO. Invaginazione cronica ileo-ceco-colica o neoplasma del cieco? (Chronic ileocecocolic invagination or tumor of the cecum?) *Radiol. med.*, June, 1932, *19*, 557–563.

The author describes a case of tumor of the cecum which had been operated on under the diagnosis of chronic ileocecocolic invagination because it presented all the roentgen signs of this disease including symptoms of stenosis of the last loop of the ileum, Busi's annular structures and distinct visibility of the opaque longitudinal striae. Operation, however, did not show invagination or any evidence that there had been an invagination that had been reduced by the opaque enema. But there was a hard nodular tumor of the cecum the size of a hen's egg. Photographs of the operation specimen are given which show the reason for the mistaken diagnosis. It was due to the fact that the roentgenograms were taken only in the posteroanterior direction without any oblique views. Oblique views should always be taken of the ileocecal region in doubtful cases and even in those in which the diagnosis appears to be simple.—*Audrey G. Morgan.*

GALIFI, LIBORIO. Mesenterite cronica in un caso di invaginazione recidivante dell'ileo per tumoretto pedunculato. (Chronic mesenteritis in a case of recurrent invagination from a small pedunculated tumor of the ileum.) *Radiol. med.*, June, 1932, *19*, 565–571.

A case is described in a man, aged thirty-five, who was sent to the hospital for chronic intestinal stenosis. Roentgen examination showed signs of periduodenitis and segmental dilatations of the small intestine which were attributed to mesenteritis. There were also signs of a moderate degree of stenosis of the terminal loop of the ileum. A diagnosis was made of stenosis of the last loop of the ileum, mesenteritis and probably periduodenitis. During the night the patient was taken with signs of acute intestinal occlusion and an emergency operation had to be performed. It showed an invagination of the ileum 7 or 8 cm. long about 40 cm. from the opening of the ileum into the large intestine. There was a pedunculated tumor about the size of a hen's egg in the invaginated part. The patient had evidently suffered from a recurrent invagination caused by this tumor. The mesentery of this part of the intestine showed chronic mesenteritis. Though the examination was not extended to the duodenum on account of the patient's condition there was probably a periduodenitis also.

Few roentgen examinations of invagination of the small intestine are described in the literature. Characteristic pictures have been described for ileocecocolic invaginations which are more benign and tend to become chronic so that roentgen examination is more frequently made. The author thinks that in all cases of stenosis of the small intestine the possibility of invagination should be considered.—*Audrey G. Morgan.*

LAURELL, HUGO. Beitrag zur Röntgendiagnose der Dünndarminvagination nebst einigen worten über die ursachen von invaginationen überhaupt. (Roentgen diagnosis of invagination of the small intestine with remarks on the cause of invagination in general.) *Acta radiol.*, 1932, *13*, 363–384.

The author thinks that the most important cause of pathological invagination is a tumor or similar structure on the wall of the intestine which is moved forward by peristalsis. If the wall of the intestine is normal he thinks that only temporary physiological invaginations can

occur. He describes the roentgen symptoms of invagination with and without contrast medium. Sometimes a positive and accurate diagnosis is possible with a contrast enema, and probably also with a roentgen meal when the latter is possible. It seems in some cases to be important to give the enema during an attack of pain.

The roentgen symptoms without contrast are the well known roentgen picture of ileus with free fluid in the abdomen. With a contrast enema there is an intermittent polypous tumor at Bauhin's valve, intermittent spasms of the cecum and ascending colon and a demonstrable invaginate in the lower ileum with the invaginating part filled with contrast.

With a contrast meal in chronic cases there is more or less retardation of the emptying of the stomach and small intestine and stenosis of the small intestine. On examination with the rays following the axis of the intestine a part of the invaginating loop can be seen as quite a broad contrast ring.

The author discusses the mechanism of invagination in general, differing in some points from the commonly accepted theories.—*Audrey G. Morgan.*

Moschetta, Giovanni. Contributo allo studio radiologico dell'invaginazione intestinale. (Roentgen study of intestinal invagination.) *Radiol. med.*, Sept., 1932, *19*, 968–990.

Four cases of invagination of the intestine are described and illustrated with roentgenograms. The author concludes that roentgen examination with contrast medium is of great importance in all cases of suspected invagination of the intestine. It can be used even in acute forms in young children and in some cases disinvagination has been brought about by an opaque enema. It is contraindicated in peracute forms and in chronic cases in which clinical examination indicates large ulcers or necroses of the invaginated part of the intestine. In these cases roentgen examination without contrast medium has often proved useful. Either the enema or the barium meal may be used, as both give characteristic pictures. It is advisable, however, to begin with the enema and use the contrast meal afterward. Palpation under the roentgen screen often gives important information in differential diagnosis. —*Audrey G. Morgan.*

Gallavresi, Luigi. Studio radiologico della modificazioni topografiche e morfologiche del tenue nel passagio dalla stazione eretta al decubito supino. (Roentgen study of the topographical and morphological changes in the small intestine on changing from an erect to a supine position.) *Radiol. med.*, Aug., 1932, *19*, 836–852.

The changes which take place in the small intestine when the subject changes from a standing to a lying position are described and illustrated with roentgenograms. With the patient standing the intestines lie in the lower half of the abdomen, chiefly in the left lower quadrant; when he lies down they move upward and occupy the upper quadrants, chiefly the left one. The upper border of the loop of jejunum which in the standing position lies below Treitz' angle, almost at the level of the crests of the ilium, rises above the duodenojejunal flexure when the patient lies down, sometimes passing under the costal arch.

The displacement is generally more marked for the upper part of the jejunum and varies in different subjects, depending on their constitution. In tall slender individuals the displacement is particularly marked, and is still more so if these individuals have more or less ptosis of the viscera. The line of the movement also differs in individuals of different constitution. In short, heavy-set persons the rise is upward and outward in a curved line with the convexity outward; in tall slender persons it is almost in a straight line parallel with the long axis of the body. There is a third intermediate type in persons of normal constitution.

The morphological study of the small intestine is easier and more complete with the patient lying than standing. Recent attempts to divide the course of the small intestine into individual loops with well-defined positions in the abdomen cannot be considered successful in view of the marked changes which take place in the position of the loops on change of position of the body.—*Audrey G. Morgan.*

Brooksher, W. R. Jr. The x-ray diagnosis of acute intestinal obstruction. *Internat. J. M. & Surg.*, Sept., 1932, *45*, 416–420.

The value of the flat film method in the diagnosis of acute intestinal obstruction is discussed. The method is entirely without danger and has the great advantages of speed and simplicity. It is applicable to all cases in which

the obstruction is accompanied by the presence of gas in the bowel. The exact site of the obstruction may not be determined but the region for the best surgical approach to the lesion may be indicated. The diagnosis is based upon the character and distribution of the gas shadows in the bowel but the interpretation must be correlated with the clinical facts. The roentgen examination does not differentiate the mechanical and the paralytic types of ileus and the use of the stethoscope is suggested in this connection.—*Author's abstract.*

ENGELSTAD, ROLF BULL. Luetische Stenosen im Verdauungstrakt. (Syphilitic stenoses in the digestive tract.) *Acta radiol.*, 1932, *13*, 249–263.

The author describes 3 cases of syphilitic stenosis of the digestive tract, one in the esophagus, the second in the colon and the third with multiple stenoses of the colon and ileum. In one of the cases the diagnosis was confirmed by autopsy; in the other two it was only overwhelmingly probable. The roentgen picture shows the lumen transformed into a narrow rigid tube which widens out uniformly above and below the stricture without any wall-like boundary. The contours are smooth and even.

The diagnosis is difficult, particularly differential diagnosis from tuberculosis. In one of the cases the author thinks the stenosis developed from chronic syphilitic ulcerous enteritis as a result of cicatricial retraction of the ulcer.—*Audrey G. Morgan.*

BECCHINI, GASTONE. Sull'antiperistalsi del colon. (Antiperistalsis of the colon.) *Radiol. med.*, June, 1932, *19*, 601–609.

Some authors maintain that there is no true antiperistalsis in the normal colon. The author gave enemas of 100 gm. barium dissolved in 200 gm. milk and egg or water to 15 subjects who were entirely normal except that some of them had slight constipation. He found that there was a true antiperistalsis and describes the three components of the movement, corresponding to those of peristalsis, showing that this was not merely a passive retrograde movement. The antiperistalsis was due to stimulation of the colon by substances not physiological for that part of the intestine.—*Audrey G. Morgan.*

GILBERT, RENÉ, and KADRNKA, SILVIJE. Du rôle de l'imprégnation colloidale dans l'examen radiologique du gros intestin en couche mince. (Roentgen examination of the large intestine by impregnation with a thin layer of colloid suspension.) *Acta radiol.*, May 15, 1932, *13*, 111–116.

A method of examining the large intestine by impregnating its walls with a thin layer of colloid suspension is described and illustrated with roentgenograms. The authors used umbrathor which sediments in very fine particles on the secretory layer which normally covers the surface of the intestine. The opaque layer is very thin, evenly distributed and elastic so that it is unaffected by peristalsis, changes of position, etc. In these respects it is superior to a barium layer, which is thicker and discontinuous and irregular. The patient is carefully prepared by light diet, a purgative, preferably castor oil and two enemas, the last an hour before the colloid enema is given, so that the irrigating fluids will have been absorbed and a layer of secretion formed.

The interpretation of the roentgenograms requires experience. But the method gives valuable information in regard to the architecture of the mucous membrane and its secretory function, the motor function of the intestine and the condition of the deep layers. Information in regard to a secretory function is furnished by the degree of opacity of the layer, its continuity and the way in which it ruptures on insufflation. If the thin layer forms at once it indicates that the motor function of the intestine is normal; if the intestine has to be distended with liquid before a layer will form it indicates a certain degree of sluggishness of movement. Information in regard to the condition of the deep layers can be obtained by the use of the thin colloidal layer in conjunction with gas distention of the intestine.

The author believes the method is superior to the classical combined method by barium meal and enema as it gives a more detailed picture and makes it possible to locate lesions better; it is simple and can be carried out rapidly.—*Audrey G. Morgan.*

LOVISATTI, NICOLA. I movimenti attivi dell'appendice. Studio radiologico. (Roentgen study of active movements of the appendix.) *Radiol. med.*, July, 1932, *19*, 692–703.

This is a study of the mechanism of the filling and emptying of the appendix with contrast medium for the purpose of roentgen examina-

tion. It is illustrated with roentgenograms and followed by a bibliography of the subject. Filling is brought about by increased pressure from the cecum and by true peristaltic waves which start from the antrum of the cecum and pass toward the base of the appendix. Not infrequently a spasm of the proximal end interferes with the filling of the appendix. Emptying is brought about by tonic contractions of the walls which force the contents of the appendix toward the cecum. This hypertonia generally begins in the proximal half which is the first to empty. The author has used antispasmodics successfully in cases in which the appendix did not fill satisfactorily, showing that the failure was due to spastic conditions.—*Audrey G. Morgan.*

Ehrenburg, G. E. Fluttering of the abdominal viscera as a complication following left-sided phrenicoexairesis. *Am. Rev. Tuberc.*, July, 1932, *26*, 77–88.

Disturbance of the gastrointestinal tract following phrenicoexairesis is quite common. The author bases the present study on 18 cases out of 58 which presented gastrointestinal symptoms following the operation. In 8 the symptoms were quite annoying, but in no case were they so severe as to interfere with recovery from the procedure. The symptoms appeared shortly after the operation and lasted for from several months to three years. The author reports that roentgen examination in these cases revealed: (1) Displacements of the stomach and duodenum to the left and upward. (2) This displacement is considerably greater in inspiration than in expiration. (3) The shape of the duodenum (normally, at roentgen examination, the cap and descending part form a sharp angle) undergoes a considerable change and presents an arch approaching a straight line. (4) By comparing the inspiratory and expiratory films, one can recognize a swinging of the pylorus and duodenum from right to left and back again, the excursion being about 2 inches. (5) The stomach shows a large bubble of air which is belched up very easily and is replaced in a few seconds. (6) High tonus of the stomach and duodenum is present. The stomach empties very rapidly, usually in two hours. (7) The swinging of the duodenum causes a constant irritation of this viscus which is apparently chiefly responsible for the various manifestations of indigestion. (8) These digestive disturbances do not interfere with recovery, though in some cases they are very annoying. (9) Light meals at frequent intervals alleviate the symptoms. The author regards "fluttering of the abdominal viscera" as the proper name for this complication.—*W. R. Brooksher, Jr.*

Huet, J.-A. Des erreurs de diagnostic au cours des urémies digestives. (Errors of diagnosis in the course of digestive uremias.) *Bull. et mém. Soc. de radiol. méd. de France*, March, 1931, *19*, 97–99.

The changes of the gastrointestinal tract during the course of uremia have formed the topic of numerous investigations. More recently, Vladesco, Simsi and Popesco have demonstrated, on the basis of experimental researches, that in uremia the stomach excretes part of the urea and transforms it into ammonia. In renal insufficiencies this transformation may augment five to ten times in volume.

The author, after making gastrointestinal examinations by means of the barium meal in several cases of digestive uremia, found that manifold appearances may occur. Some cases gave the impression of typical duodenal ulcers, others of neoplasms and again others of spasms.

The conclusion is reached that the findings of the gastrointestinal tract in uremia are not characteristic and that the roentgen examination must always be supplanted by the clinical observation. In this manner unnecessary operative procedures which might appear indicated on the basis of the roentgen examination alone may be prevented.—*T. Leucutia.*

Fetzer, H., and Hoppe, G. Die Anwendung des Thorotrast bei der Diagnostik intra-abdominaler Tumoren. (The use of thorotrast in the diagnosis of intra-abdominal tumors.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1931, *44*, 752–757.

The authors injected thorotrast for the diagnosis of an intra-abdominal tumor in a man aged thirty-eight, who four years previously had a sarcoma of the testicle removed. The patient died later and a post-mortem examination was made. In harmonizing the clinical and roentgen findings with those observed at autopsy it was found that the thorotrast failed to demonstrate the presence of the hepatic metastatic nodules. The liver appeared on the roentgenograms enlarged and of a uniform

density but without showing the negative shadows which one might expect from non-absorption of the thorotrast within the metastatic nodules.—*T. Leucutia.*

GYNECOLOGY AND OBSTETRICS

HEUSER, CARLOS. Radiographie du placenta. (Roentgenography of the placenta.) *Bull. et mém. Soc. de radiol. méd. de France*, Dec., 1932, *20*, 646–649.

In a previous paper presented at the meeting of the Radiological Society of North America at St. Louis in November, 1931, the author included a roentgenogram of a gestating rabbit in which the placenta was distinctly shown. In 1932 Ehrhardt published an article in the *Klinische Wochenschrift* on the roentgenography of the placenta in mice. This induced the author to continue his studies, arriving at the following results: (1) It is possible to obtain a roentgenogram of the placenta in vivo. (2) The fetal placenta shows the greatest impregnation with the thorium salt. (3) In several fetuses of the animals the thorium is demonstrated in the spleen of the fetus. This last point constitutes the greatest contribution of the investigation, destroying the theory according to which substances do not pass from the mother to the fetus, the placenta acting as a filter.

In the human the author injected a case of advanced tuberculosis, with a positive result. The thorotrast solution was employed in conjunction with isamine blue by using the technique formerly described by the author. A good visualization of the placenta was obtained. However, this presentation constitutes only a preliminary report.

Béclère in discussing the presentation (*Bull. et. mém. Soc. de radiol. méd. de France*, Jan., 1933, *21*, 24) states that no convincing proof has been brought that the thorium has passed through the placenta filter from the mother to the fetus. This point seems to be in contradiction to the conclusions of Bonorino Udaondo, Maissa and Zunino who, reporting on the same subject in the October, 1932, number of the *Prensa medica argentina*, state definitely that the passage of the thorium salts from mother to fetus cannot be proved. Liverani likewise was unable to demonstrate histologically in the liver, spleen and fetal bone marrow traces of thorium, although the placenta was very well impregnated, proving that the placenta has retained this substance.—*T. Leucutia.*

GENITOURINARY SYSTEM

BIANCHINI, ALESSANDRO. Sulle scoliosi nefrogene. (Nephrogenic scolioses.) *Radiol. med.*, Aug., 1932, *19*, 852–856.

A great majority of the cases of kidney disease cause scoliosis, particularly in the dorsolumbar region. The author made a study of his private material and that of the roentgen laboratory of the surgical clinic of the University of Rome and found that kidney disease not only causes scoliosis but that the direction of the curvature is influenced to a great extent by the nature of the disease. He gives the figures for the different diseases which show that the concavity is toward the diseased side in the majority of cases of hydronephrosis, pararenal abscess, pyelitis, renal tuberculosis and floating kidney, while the convexity is toward the diseased side in the majority of cases of renoureteral calculus and renal tumors. He discusses the causes of this and concludes that probably a concave scoliosis is a result of contracture of the psoas and quadratus lumborum muscles while a scoliosis convex toward the diseased side is a result of a compensating position of defense.—*Audrey G. Morgan.*

THOMSEN, EINAR. Studies of the female urethra, especially as regards the closing mechanism of the bladder. *Acta radiol.*, 1932, *13*, 433–458.

In a previous paper the author has described a special roentgen method of examining the female bladder which he uses. In this paper he describes a new series of examinations which he has made with this method which throw light on the mechanism of closing of the female bladder. He thinks that the closing mechanism is primarily a function of the urethra itself and only secondarily of the surrounding tissues. He has demonstrated an angular bend in the urethra and when this is not present the closing mechanism fails. The practical conclusion that he draws from this is that an operation for incontinence should support or tighten the anterior wall of the urethra. This is more difficult than approaching the posterior surface, which is easy to find, especially if there is a cystocele. He describes a case which he has operated on by the new method; the woman has complete control of the bladder for the first time in thirteen years.—*Audrey G. Morgan.*

Ledoux-Lebard, R., Garcia-Calderon, J., and Petetin, J. L'exploration radiologique de l'urèthre masculin (uréthrographie) et de la prostate. (Roentgenologic exploration of the male urethra (urethrography) and of the prostate.) *J. de radiol. et d'électrol.*, Sept., 1931, *15*, 473–490.

The roentgen exploration of the urethra and prostate by means of opaque substances, despite its great advantages and exceptional value, does not occupy the position which it deserves. The authors, from rich experiences, believe that the method should be employed systematically as a supplement to other routine procedures (sounding, urethroscopy, digital examination, etc.). No other method furnishes such precise information concerning the anatomic state of the urethra, adnexal glands of the posterior urethra and postoperative sequels.

Armamentarium. The injection is made in a manner similar to that of hysterosalpingography under manometric control, the pressure not exceeding 30 cm. of mercury. The Janet syringe was first used but because of its imperfect adaptation to the urethral orifice, it was later replaced by a rubber sound of rather large caliber. The sound is introduced for a few centimeters into the urethra, just beyond the balanic portion, and kept in position by means of a compress, the two ends of which are thrown back and fastened with an elastic clamp in the balano-preputial groove. The pressure of the compress produces a hermetic occlusion of the canal upon the sound during the time of non-injection. A 50 c.c. syringe, which is provided with a special faucet so as to permit the reflux of the opaque material, is used for the actual injection. Stereoscopic roentgenograms are made.

Preparation of the Patient. If the roentgenogram is taken while the patient urinates the opaque substance, the bladder must be kept full, whereas in the other procedures in which lipiodol is used the bladder must remain empty. A preliminary evacuation of the rectal ampulla is of prime importance. No anesthesia of any kind is required, except in unusual cases (sphincteric spasm) when novocain is used.

Position of the Patient. This varies according to the method used. It may be (1) Direct: (*a*) with the patient half sitting, (*b*) with the patient in ventral decubitus, the incidence being dorsoventral, and (*c*) with the patient erect (when the roentgenogram is taken during urination). (2) In profile, and (3) oblique. This latter is used by the authors routinely because of its greater advantage in demonstrating the entire course of the urethra. The patient is placed in right (or left) oblique decubitus, the transverse axis of the pelvis forming an angulation of 45° to 50° with the plane of the table. Sandbags are placed under the thigh and back for support. The right thigh is flexed at a right angle to the pelvis, and is placed in abduction with the external aspect lying on the surface of the table, the leg being flexed on the thigh. The left inferior extremity is elongated. At the moment of exposure, the patient pulls the penis to the right, holding it with his right hand which rests on the flexed thigh. In this manner the penile and perineal scrotal portions of the urethra appear in a straight line and parallel with the plane of the film.

Opaque Substances. Various opaque substances were tried such as collargol, sodium iodide, sodium bromide, etc., but they proved of only limited value. Since the advent of lipiodol this substance has been used nearly exclusively. Recently, umbrenal, uroselectan and umbrathor have been found to be somewhat more practical because of their easier manipulation. At the present time the authors are experimenting with certain thorium salt colloids which have the great advantage that they are not oily and that they are miscible with the urine and various organic fluids.

Technique of Examination. (*a*) Roentgenography of the anterior urethra. The injection of 10 c.c. lipiodol is entirely sufficient for the roentgen visualization of the penile urethra up to the bulb; (*b*) roentgenography during urination. There are three known procedures: (1) The bladder is filled with 150 c.c. opaque solution and this is urinated during the actual taking of the roentgenograms, best in erect position. (2) The patient partakes of 200 c.c. of water the night before and does not urinate the morning of the examination; 15 to 20 c.c. of undiluted umbrenal is injected just previous to the examination and the films taken during urination (technique of Puhl), and (3) roentgenography following intravenous injection of uroselectan, the patient urinating the opaque solution of the filled bladder during the taking of the roentgenogram. (c) Roentgenography during actual injection (retrograde urethrography). This method is used with preference by the authors because of its great simplicity

and accuracy. The rubber sound is introduced into the urethra as stated above, and first 10 c.c. of the opaque substance (lipiodol) injected, filling the anterior portion of the urethra. When everything is ready for the taking of the roentgenogram, 15, 20 or 30 c.c. additional opaque solution is injected rapidly, the roentgenogram being taken during the actual injection. It is very important that the injection be made uniformly under constant pressure, so as not to produce artificial break of continuity in the line of the opaque substance. It is advisable to first warm the lipiodol to body temperature. The technique of injection is considerably simplified when using aqueous solutions of thorium salts, as practised recently by the authors. Roentgenograms are taken with the patient in oblique position, as described above, by using the Potter-Bucky diaphragm and by making stereoroentgenograms (which are of great aid especially in the study of the posterior urethra and prostatic region).

The author then describes in detail the normal appearance as well as the changes which are encountered in various pathologic lesions. The method is of value in the study (1) of the urethra; in congenital anomalies, calculi and foreign bodies, diverticula, and especially strictures (differentiation of strictures of the penoscrotal and strictures of the bulbar urethra), (2) of the accessory glands of the posterior urethra; in differentiating the normal glands from prostatic crypts, cavities or fistulae. In case of simple hypertrophy or early carcinoma of the prostate a rather important modification of the trigone region and of the posterior urethra is found but an accurate differentiation of the two conditions is not possible. An interesting observation was made in postoperative cases of suprapubic prostatectomy. Because of operative injury of the internal sphincter (the external sphincter remaining intact) a sinking of the urine (and consequently of the opaque substances) as far as the mid-portion of the posterior urethra is noted.—*T. Leucutia.*

BROOKSHER, W. R., JR. Diverticulum of the bladder. *Urol. & Cutan. Rev.*, Dec., 1932, *36*, 806–807.

The symptoms, diagnosis and treatment of bladder diverticula are discussed. The cystogram, with exposures from more than one angle, is always advisable to differentiate retention from non-retention types. In cases of severe cystitis, obstructive prostate and the like, a satisfactory cystoscopic examination may be impossible, necessitating recourse to the cystogram alone for diagnosis. A possible error in the interpretation of the cystogram is to mistake for a large diverticulum a portion of a greatly relaxed bladder that has been compressed by extra-vesical pressure, causing the shadow of the dome to be projected by the rays in such a manner that it appears to be independent of the bladder proper.—*Author's abstract.*

BUISSON, PAOLO. L'uretero-pielografia retrograda nell'idronefrosi. (Retrograde ureteropyelography in hydronephrosis.) *Radiol. med.* April, 1932, *19*, 369–390.

The author discusses 500 cases of ascending ureteropyelography carried out without the slightest difficulty. Thirty-eight roentgenograms are reproduced and brief notes in regard to the clinical details of the case given beneath each of them. He concludes that it is possible by means of retrograde ureteropyelography not only to diagnose hydronephrosis but even in many cases to determine its etiology and pathogenesis and to decide what treatment to adopt. In all these cases the ureteropyelographic findings were confirmed by laboratory examinations and also by surgical operations in all the cases in which operation was necessary.—*Audrey G. Morgan.*

WOHLERS, H., and KADRNKA, S. La néphropyélographie et sa valeur clinique; une nouvelle substance injectable dans les veines, "l'abrodil." (Nephro-pyelography and its clinical value; a new substance for injection into the veins, "abrodil".) *Presse méd.*, Oct. 7, 1931, *39*, 1473–1476.

The authors, after discussing the historical development and the technique of intravenous pyelography, as well as the interpretation of the roentgenograms so obtained, give the following tabular arrangement of the roentgen findings:

A. Nephrogram. Normal opacity: (1) normal parenchyma; (2) normal excretory paths.

Exaggerated or prolonged opacity: (1) general or local circulatory disorders (stasis); (2) parenchymatous alteration, predominatingly tubular (one group of chronic nephritis and the nephroses); (3) hypofunction of the excretory paths: (*a*) hypokinesia of central or local origin

and (*b*) stasis (calculi, kinking, torsion, ptosis, aneurysm, pregnancy).

Diminished or absent opacity: (1) absence of the kidney; (2) extensive parenchymatous alteration, predominatingly glomerular (tumors, advanced hydronephroses); (3) vascular disorders; (*a*) general (reflex anuria) and (*b*) local (extrinsic compression of the renal artery).

B. Pyelogram. Normal opacity: Same as in nephrogram. Cause of error, dysfunction in certain dysendocrinian states.

Exaggerated or prolonged opacity: (1) obstruction of the path between the bladder and kidney pelvis: (*a*) organic (malformation, calculi, tumor, kinking, torsion, renal ptosis, aneurysm, pregnancy), (*b*) functional (hypokinesia of central origin, as in lesions of the cord, or of peripheric origin, as in pregnancy) and (*c*) moderate hydronephrosis.

Diminished or absent opacity: (1) poor elimination: circulatory disorders (aged subjects), purulent affections (tuberculosis), parenchymatous involvement (tumors, including polycystic kidneys), very advanced hydronephrosis, neuro-endocrinian disorders (polyuria); (2) exaggerated excretion: medicinal or nervous hyperkinesia.

The indications are summed up as follows: (1) absolute indications: Impracticability of ascending pyelography; congenital malformations; stricture and stenosis of the ureter; hypertrophy of the prostate; sclerotic and atrophic bladder; severe or hemorrhagic cystitis; vesical fistulae; obstruction of the ureter (calculus, tumor); external compression of the ureter (tumor, aneurysm); children; adnexitis; general debility; near-term pregnancy; refusal of catheterization; (2) relative indications: cases in which ascending pyelography carries a certain risk; poor general condition; inflammations (of the urethra, bladder, adnexa); mid-term pregnancy; (3) new indications (nephrography); malformations (horseshoe kidney, etc.); renal tumor; chronic inflammations, especially renal tuberculosis; and association with ascending pyelography.

The conclusion is reached that the intravenous injection of abrodil is entirely harmless leading to very valuable information in a number of lesions of the urinary tract.—*T. Leucutia.*

Petrignani, Roger. Quelques résultats obtenus par la néphropyélographie par milieux de contraste (urosélectan et abrodil). (Certain results obtained by nephropyelography by means of contrast media (uroselectan and abrodil).) *Bull. et mém. Soc. de radiol. méd. de France*, June, 1931, *19*, 291–296.

After describing the technical procedure as well as the roentgen appearance of the urinary tree following intravenous pyelography in the normal and in certain pathologic conditions, the author discusses the value of the method for the functional exploration of the kidneys. In this respect he makes a distinct differentiation between the threshold of elimination (which in the normal is ten to fifteen minutes after the injection) and the duration of the elimination. A rise of the threshold with a prolonged elimination as a rule indicates an impairment of the function of the kidney. In complete destruction no image is obtained. In one case with impaired function, the author after individual catheterization of the ureters found a ureochloruric dissociation, one of the kidneys eliminating the chlorides and the other the urea. Whereas the first showed a normal excretion of the opaque substance, the second revealed impaired excretion. Thus it seems that intravenous pyelography gives information only concerning the urea secretoric function of the kidney. The author states, however, that he does not wish to draw final conclusions as yet.—*T. Leucutia.*

Nemours-Auguste. Sur la pyélographie intraveineuse par l'abrodil. (Intravenous pyelography with abrodil.) *Bull. et mém. Soc. de radiol. méd. de France*, 1931, *19*, 83–85.

Abrodil presents the following advantages: It is a limpid solution and produces no reaction. The image obtained is of better quality than that with uroselectan. Although it is injected in quantities of 40 gm. the author believes that 30 gm. would be sufficient.—*T. Leucutia.*

Legueu, Fey, and Truchot. Urographies intra-veineuses par une substance nouvelle: le Tenebryl. (Intravenous urography by means of a new substance: tenebryl.) *Bull. et mém. Soc. de radiol. méd. de France*, Nov., 1931, *19*, 448–450.

Since June, 1931, a new substance has been used at the Necker Hospital for intravenous urography. It is called tenebryl and it represents a di-iodo-methane sulphonate of sodium. It is manufactured by Marcel and André Guerbet who also produce lipiodol Lafay.

The chemical constitution of tenebryl is similar to that of abrodil except that there are two atoms of iodine instead of one, this increasing the iodine content to 68.6 per cent. The solution is very stable but must not be exposed to light. The atomic weight because of the increased content of iodine is high (370) and the solution, even in concentrated form, is only slightly hypertonic (the isotonic solution corresponding to 6 per cent).

The elimination occurs nearly exclusively through the urinary tract, with great rapidity.

The rich iodine content (68.6 per cent as compared to 42 per cent in uroselectan and 52 per cent in abrodil) and the rapid elimination are two important characteristics permitting a considerable reduction in the amount necessary for the injection. Thus 15 gm. of the substance is sufficient, whereas 20 gm. of uroselectan or abrodil is necessary to produce good images. No reaction whatever was observed, the preparation being well tolerated. The injection is best made on an empty stomach.

Very satisfactory results were obtained in more than 50 trials. The best filling was obtained between the seventh and tenth minute, the visibility of the urinary system progressively decreasing for an hour and a half after the injection.—*T. Leucutia.*

HAENISCH, F. Die röntgenologische Untersuchung des Harnapparates vermittels der Ausscheidung von kontrastgebenden Substanzen. (The roentgen examination of the urinary apparatus by means of excretion of contrast-giving substances.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1931, *44*, 557–573.

The author discusses the present status of roentgen visualization of the urinary apparatus by means of contrast media injected intravenously. The following points are of interest: No improvement of the roentgen image is obtained by various artificial procedures applied following the injection of the contrast medium, as, for example, by allowing the patient no water to increase the concentration or by various compressions, etc. Abrodil (or skiodan, as it is called in America) proved of greater advantage than uroselectan. The peroral or rectal administration, as practised in cholecystography, does not give satisfactory results as yet. More recently "uroselectan B," a new pyridin preparation containing 51.5 per cent organically bound iodine, which is put up in sterile ampules, is used. This permits a considerable decrease in the amount of the substance injected, only 15 gm. (20 c.c.) of the preparation being necessary. The injection must be made very slowly in a manner similar to that of uroselectan in order to prevent the uncomfortable sensation of heat. The ureters are well visualized with this new preparation. There can be no doubt, however, that the last word has not been said as yet concerning the best opaque medium. As a whole, excretion pyelography must be considered as a valuable and harmless method which is free of any untoward effects and, therefore, may be applied in ambulatory patients. It may be used in all ages and all types of kidney lesions, except uremia. It also has a certain value in the study of the function of the kidney although it is less accurate than the injection of methylene blue.

In the last part of the article the value of pyeloscopy, nephrography, the physiologic behavior of the ureters, the appearance in pregnancy, the visualization of bladder tumors and especially the diagnostic value in stones, is discussed. The opinion is expressed that excretory pyelography should not replace instrumental pyelography, but that both should be used in conjunction. Yet, in many instances, because of its great simplicity, excretory pyelography will have first choice.—*T. Leucutia.*

BIANCHINI, ALESSANDRO. Lo studio morfologico delle cavita renoureterali attraverso la comparazione fra il metodo urografico e pielografico (discendente ed ascendente). (Comparative morphological study of the kidney and ureters by the descending urographic method and the ascending pyelographic method.) *Radiol. med.*, March, 1932, *19*, 297–308.

In a report made before the International Congress of Radiology in Paris in July, 1931, the author studied the comparative merits of the descending method of pyelography with uroselectan and abrodil and the ascending method with umbrenal. At that time he concluded that while the ascending method gave greater opacity and detail in the roentgenograms the descending method was superior from the point of view of morphology and function. Since that time he has made comparative studies of the ascending and descending methods, using uroselectan for both. From this new work he concludes that the ascending

method with uroselectan is by far the best. No descending method gives so clear and detailed a picture of the kidney pelvis. There is none of the pain and reaction that there is with umbrenal. It is the only method with which pyeloscopic examination can be made. It is simple, harmless and economical. Since making this series of experiments he has had some even better results with uroselectan B, which is more opaque. The ascending method with uroselectan should be used in all cases in which it is possible.

Twenty-eight roentgenograms are given showing various pathological conditions of the urinary tract that require surgery; these the author says show better than words the value of his method.—*Audrey G. Morgan.*

Migliardi, Luigi. La pielografia endovenosa nella tubercolosi renale. (Intravenous pyelography in kidney tuberculosis.) *Radiol. med.*, May, 1932, *19*, 451–469.

The author discusses 21 cases of unilateral tuberculosis and 5 of bilateral tuberculosis in which he used intravenous pyelography with uroselectan, abrodil or uroselectan B, and illustrates them with roentgenograms. He describes his technique and concludes that intravenous pyelography is an important method of examination in kidney tuberculosis. Even when it is possible to diagnose the disease by the ordinary methods it confirms the diagnosis of the site of the lesions and the functional value of the kidneys. In cases of kidney tuberculosis in which the bladder cannot be examined intravenous pyelography in combination with a study of function makes it possible to determine the indications for operation. It is the only method of demonstrating closed foci of kidney tuberculosis.—*Audrey G. Morgan.*

NERVOUS SYSTEM

Edling, Lars, and Ingvar, Sven. Über Myelographie mit kleinen Kontrastmengen. (Myelography with small amounts of contrast medium.) *Acta radiol.*, 1932, *13*, 239–248.

In myelography by the original technique of Sicard and Forestier there have been signs of irritation of the meninges and quite alarming meningeal symptoms have been seen after the use of the method of Odin and Rünstrom—the injection of 4.5 to 10 c.c. iodized sesame oil. The authors, therefore, at the Lund Clinic, tried to decrease the contrast medium to the minimum. They have found that satisfactory examinations can be made with 0.25 c.c. lipiodol injected suboccipitally or intralumbally. They give histories and roentgenograms of 11 cases which show that this is generally sufficient to give a satisfactory diagnosis of tumors or other changes with compression of the cord. The lipiodol enters the subarachnoid space in fine drops that stop at the upper or lower border of the tumor, often in the shape of arches around its contour. All the cases were verified by operation or autopsy. Control cases without tumors gave negative results. There were no symptoms of irritation at all with this technique.—*Audrey G. Morgan.*

SKELETAL SYSTEM

Møller, P. Flemming, and Gudjonsson, Sk.V. Massive fluorosis of bones and ligaments. *Acta radiol.*, 1932, *13*, 269–294.

The authors report the results of their examination of 78 workers engaged in the crushing and refining of cryolite. Thirty-nine of them had silicosis, some of them to the second degree and the following three diseases were also common among them:

1. A curious sclerotic affection of the bones, ligaments and muscle attachments, probably caused by the deposition of calcium fluoride in the bones. The authors think that this disease has not been described in man before. It was found in 30 of the workers.

2. An acute affection of the stomach probably caused by slight corrosion of the mucosa from some of the fluorine in the cryolite dust that was swallowed being changed into hydrofluorine by the hydrochloric acid of the stomach.

3. A pronounced oligemia found in 11 of the 30 workers who showed pathological changes in the bones.

These changes in the bones are described in detail and the causes of these and the other symptoms and their connection with the fluorine contained in the cryolite are discussed. The results of the investigation are compared with those of an investigation made of 21 other workers in industries in which fluorine and materials containing fluorine are used. Animal experiments in feeding cryolite are also mentioned but a more detailed description of them will be given in a later article. The author also give a preliminary report on experiments

in fluorine therapy for certain bone diseases.—*Audrey G. Morgan.*

DI BELLA, FILIPPO. Sarcoma vertebrale primitivo. (Primary sarcoma of the vertebrae.) *Radiol. med.*, April, 1932, *19*, 410–415.

The author describes a case in a girl of eleven who had a swelling on her back in the lumbar region which she attributed to a blow suffered five months before. Soon after the trauma the swelling began and had increased in size; pain with exacerbation on movement had become more intense and more continuous. On roentgen examination the right transverse process of the third lumbar vertebra showed an opaque prolongation which was finely arborescent and surrounded by a tumor mass the size of a lemon. The 4th lumbar showed erosion of all the right margin of the body and destruction of the transverse process and part of the vertebral arch on that side. In the lateral projection it showed a small round proliferation on its anterior margin. Examination of a small piece removed from the mass showed a typical fusiform cell sarcoma. Intense roentgen treatment stopped the pain but did not affect the size of the tumor. Another roentgen examination twelve days after the last irradiation did not show any difference in the size of the tumor. The patient was dismissed and returned after four months in much worse general condition. The tumor had increased in size and there was diffuse demineralization of the whole spinal column; the intervertebral discs were preserved.

The author was only able to find 6 cases of primary sarcoma of the vertebrae described and illustrated with roentgenograms. He thinks every such case should be carefully and accurately recorded.—*Audrey G. Morgan.*

GESCHICKTER, CHARLES F. Osteogenic sarcoma. *Arch. Surg.*, 1932, *24*, 602–659; 798–867.

Neoplastic lesions in their development repeat the normal histogenesis of the part affected. For this reason, an analysis of normal histogenetic processes should prove most significant in a study of the origin of various forms of tumors. On such a basis it is possible to divide the malignant bone forming sarcomas into a cartilaginous and fibro-osseous series. These two major divisions correspond to the two fundamental types of osteogenesis observed in the human embryo, the intracartilaginous and the membranous.

The two major groups of osteogenic sarcomas have been divided by the author into an early and a late form. The early form of cartilaginous tumor arises from precartilaginous connective tissue and has the power of forming both cartilage and bone. It has often been referred to under the misnomer "chondromyxosarcoma." The late form of chondral sarcoma arises from tissue that has already differentiated into cartilage and takes its source in the proliferation of chondroblasts. This form of tumor has not been widely recognized as an entity and is most often confused with other tumors such as angiosarcoma and the so-called metastatic giant cell tumor.

The earlier type of the fibro-osseous series of malignant tumors is related to the formation of cancellous bone, and is only potentially bone-forming. In the early literature this is called "malignant bone aneurysm." The late type of this series is related to the formation of cortical bone, and arises from fibrous tissue capable of direct osseous formation. Pathologists have referred to it as "sclerosing" sarcoma.

This study is based on an analysis of over 350 cases of osteogenic sarcoma. This division into a cartilaginous and fibro-osseous series, each with an early and a late form rests on a sound histogenic basis and aids materially in the comprehension of the nature of the malignant process, permits greater accuracy in diagnosis, prognosis and methods of treatment.

Part I. The Chondral Forms Of Osteogenic Sarcoma

The earliest type of the chondral forms of osteogenic sarcoma may be subdivided into primary and secondary types. These early forms of cartilaginous tumors have recently been described by Phemister under the name of chondrosarcoma.

Primary Chondrosarcoma. This is a very malignant tumor arising periosteally, which does not primarily involve either the cortex or medullary cavity of the bone. It is emphasized that this primary periosteal chondrosarcoma is not derived from cartilage or misplaced tissue at the epiphyseal line which has been the stereotyped explanation for tumors of the bone containing cartilage. Instead it arises in precartilaginous connective tissue which persists normally at points of tendinous attachments to

bone, about joints, especially at the point of reflexion of the joint capsule and in the synovia.

Clinically, the primary chondrosarcoma involves the regions of the knee or shoulder, and is particularly frequent at the adductor tubercle of the femur which forms the insertion of the adductor magnus and the tibial tuberosity where the quadriceps extensor is inserted and at the greater tuberosity of the humerus where the supraspinatus muscle is anchored. The youthful age of the patient, between fifteen and twenty years, the brief duration of symptoms, less than six months, and the rapidly fatal course terminating in most instances within fourteen months after treatment, emphasize the extremely primitive character of the tissue of origin. The roentgenologic features are also distinctive. It is one of the few lesions that produce a periosteal reaction and a soft part shadow without noticeable effect in the early stages on either the cortex or the medulla. On palpation there is noted a firm rubbery tumor which presents a larger bulk than the roentgenogram would seem to indicate. At operation the tumor presents a characteristic lobulated, bluish-white and translucent mass. Despite these diagnostic features and the fact that this tumor constitutes over one-eighth of all malignant lesions of the bone in a series of over 1,700 benign and malignant tumors, the primary form of chondrosarcoma is practically never distinguished by clinicians as an individual type.

There are only 2 instances among 84 cases of this tumor in which a permanent five-year cure has been established. When the tumor involves the extremities, an early amputation undoubtedly is of the greatest benefit. Radiotherapy is worthy of trial.

Details of the clinical and the pathologic picture were discussed by the author in a preceding paper. A typical case report with illustrations is given which emphasizes the three essential features of the primary chondrosarcoma. This triad is, first, the features in the history of an acute course of trauma, pain, tumor and dysfunction in a patient under thirty years of age; second, the findings on examination of a tumor which is rubbery to palpation and larger than the translucent periosteal shadow in the roentgenogram seems to indicate, and third, a microscopic picture in which there is a characteristic transition from embryonic connective tissue to myxoma to cartilage to bone in which bizarre forms of fetal and adult cartilage predominate.

Secondary Chondromyxosarcoma. Chondromyxosarcoma is a tumor which is superimposed upon a benign growth of the osteochondromatous and chondromatous types. These benign growths are either exostoses or chondromas. Their ability to give rise to chondromyxosarcoma is due to the persistence within them of functioning precartilaginous connective tissue.

On the basis of the microscopic section, the distinction between the primary and secondary chondrosarcoma cannot often be made. Clinically, however, there are distinctive features. In contrast, the secondary form occurs most frequently after thirty years of age, the history is usually a vague rheumatic complaint, with weakness or deformity persisting over a period of many years (from five to twenty-five) and complicated in recent months by more severe symptoms of pain and swelling. The roentgen findings are far more varied and depend upon the nature of the preceding benign lesion and the duration of the malignant change. In the exostosis the earliest change is periosteal. A haziness in the outer margin of the exostosis rapidly extends downward producing a granulating and spotted destruction in the medullary cavity of the bone beneath. Even in late cases in which the benign bony outgrowth has been completely destroyed, the widened metaphyseal region typical of exostoses gives evidence of the secondary nature of the sarcoma.

When a central chondroma is the site of the malignant change, the persistence of the multilocular structure of the original tumor or the existence of other benign chondromas will indicate the true nature of the sarcoma. A secondary chondrosarcoma may be engrafted upon a Paget's osteitis deformans.

The clinical course and the response to the various methods of treatment are typical. Slow growth to a tremendous size, recurrence after incomplete removal, and slow development of metastases, are the rule. Therapeutically, the best results are obtained by amputation or radical excision followed by radium therapy

Microscopically, the distinction between primary and a secondary chondrosarcoma is difficult to make. As a rule, the sections in secondary chondrosarcoma are predominated by myxoma and necrotic cartilage, whereas in primary chondrosarcoma there is a greater mixture of cells with a transition through all

phases of osteogensis—from connective tissue to cartilage to bone with pleomorphic forms of cartilage predominating. The distinction between a secondary chondrosarcoma and a benign chondroma is even more difficult. The differentiation must be made by other criteria. Cartilaginous tumors of the small bones of the hands and feet (excluding the os calcis) may be regarded as benign regardless of the microscopic picture. All central tumors of the long bones composed predominantly of cartilage, particularly those showing recent increase in size or intensity of symptoms, must be looked on as potentially malignant. As long as an exostosis in the roentgenogram has a pedicle of normal osseous tissues and a cartilaginous cap distinctly outlined by calcification, malignant change may be excluded. In the benign central chondromas a translucent central area of osseous destruction, traversed by interlacing demarcations and surrounded by a definite bone shell, distinguishes these lesions from those growths in which malignant change has occurred and wherein there is usually a hazy and invasive periosteal growth beyond the bone shell, in addition to a granular and spotty change within the central area. Under the microscope the benign chondromas are usually composed of fairly uniform adult cartilage which closely resembles the normal chondral type, and the fibrous septums that lobulate the tumor are in a quiescent hyalinized state.

A number of case reports with illustrations are given. These reemphasize the points brought out in the preceding discussion.

Chondroblastic Sarcoma

This tumor arises from the cartilage cells of the epiphyseal line in adolescence, and is one of the more malignant forms of osteogenic sarcoma, but fortunately is infrequent. This tumor has not yet been recognized as a histogenetically distinct entity as evidenced by the various names that have been applied to it.

Clinical features:—The age incidence, the site, and the short duration of symptoms and clinical course are the outstanding features of this tumor. Patients about the age of puberty are chiefly affected. These tumors occur where skeletal growth is most active, namely, at the upper end of the humerus and tibia and the lower end of the femur and radius. In patients under twenty the average duration of symptoms is less than five months while in the rare cases in which the patients are thirty years or over the duration of the disease averages over three years. The history and symptoms are similar to other types of osteogenic sarcoma. Fever, leucocytosis and enlargement of the regional lymph nodes are not infrequent.

Roentgenologic features:—The outstanding features are the relationship of the tumor to an ossifying epiphyseal line and the association of a definite translucent periosteal reaction with a central area of multilocular osseous destruction. The tumor is found primarily in the metaphysis as this is the zone of most active bone growth. There is often a marked resemblance to benign giant cell tumor from which it can be distinguished by the fact that the giant cell tumor usually occurs in persons over twenty, is confined largely to the epiphysis, is coarsely trabeculated, and produces little or no periosteal reaction. The age of the patient aids in distinguishing this tumor from a solitary focus of metastatic carcinoma. Ewing's tumor may be a source of confusion. In Ewing's sarcoma there is more formation of new bone, a more diffuse involvement of the shaft with an extension to the midshaft region, and the involvement of the epiphysis so characteristic of chondroblastic sarcoma is never seen in early cases.

Gross pathology:—While this tumor may extend into the soft parts, the bulk of the neoplasm is usually within the medullary cavity. The tumor evidently does not disseminate as readily within the cancellous bone as it does in the subperiosteal spaces. The most important information to be had from the gross specimen is the continuity between the tumorous mass and the unossified epiphyseal line. The character of the tumor tissue is often indistinguishable from the hemorrhagic grumous material found in giant cell tumor or the vascular cavitation in the so-called malignant aneurysms of the bone. The occasional zones of cartilaginous material and the connection with the unossified epiphyseal line should arouse suspicion of chondroblastic sarcoma.

Microscopic features:—This lesion is essentially composed of a mass of young and adult cartilage cells, of the hyaline variety, undergoing calcification. It is extremely vascular. The absence of precartilaginous connective tissue and the vascularity distinguish this tumor from the primary and secondary forms of chondrosarcoma. An important distinguishing

feature is the fact that the end-product of the tumor never passes beyond the stage of calcification. The tumor may therefore be designated as a calcifying chondrosarcoma as opposed to the chondromyxosarcomatous form which ossifies. Giant cells of the epulis type are found toward the periosteal margin of the growth. This has led to an erroneous diagnosis of a benign giant cell tumor.

Histogenesis:—This tumor is definitely connected with the chondroblastic activity occurring on the metaphyseal side of the epiphyseal lines of long bones. During adolescence there is a final spurt of growth in length of the appendicular skeleton at the upper end of the humerus and tibia, and the lower end of the femur and radius. Accompanying the chondroblastic proliferation as a part of the normal development of bone is the presence of osteoclastic giant cells and an increase in vascularity. An abnormal production of cartilage cells and the failure of normal ossification to occur results in a malignant tumor of the chondroblastic variety. The vascularity and the giant cell areas are secondary features but have led to the microscopic diagnosis of giant cell tumor or angiosarcoma.

Prognosis and treatment:—The usual duration of the disease from the onset of the first symptoms to death does not exceed two years. The prognosis is unfavorable. Irradiation has been found of value in the treatment of these cases. From a study of 14 cases, the conclusion seems warranted that unless an early amputation can be performed, operative intervention should always be followed by irradiation, perferably by competent radium therapy. The radium dosage, however, must be adequate and should not be attempted unless at least 120 mg. are available.

Conclusions Concerning the Chondral Forms of Osteogenic Sarcoma

In the chondral forms of osteogenic sarcoma that have been discussed there is little choice between the various types from the standpoint of prognosis so far as the microscopic examination is concerned. Far more significant is the clinical question of whether the tumor is of primary or secondary origin. Five-year cures are from two to three times as great among the chondrosarcomas of secondary origin as in either the primary or chondroblastic forms.

The chondral forms of sarcoma are intimately connected with the process of histogenesis. These sarcomas arise either during a process of differentiation in tissue at a zone of growth during the normal period of growth, as in the primary and chondroblastic varieties, or in an embryonic rest from relatively undifferentiated tissue persisting in a quiescent state in some benign tumor of the bone, as in secondary chondrosarcoma. In this latter instance, the undifferentiated tissue develops into a sarcomatous growth after some local injury stimulates a reparative process in the benign tumor. Thus, in all forms of chondral sarcomas the degree of malignancy depends not only on the degree of differentiation of the cell of origin, but on whether or not the process of differentiation is concerned with an impetus to normal growth.

Part II. The Fibro-osseous Forms of Osteogenic Sarcoma

Two types of ossification occur in the long bones of the skeleton. The cancellous portion of a bone is formed by the so-called intracartilaginous type of ossification while the cortex is an example of membranous ossification. The tissue of origin of these two types of ossification may give rise to a distinct form of sarcoma. The neoplasm arising in the cancellous bone is central in origin and osteolytic in character. The cortical tumor is periosteal in origin and sclerosing in character.

The Osteolytic Form of Osteogenic Sarcoma

This lesion is not frequently described as a separate entity. Referred to in the older literature under the name of malignant cyst, bone aneurysm and angiosarcoma. It is rarely recognized in the roentgenogram and even with microscopic examination it is often erroneously diagnosed osteitis fibrosa or giant cell tumor.

Clinical features:—The age incidence is between ten and twenty, although it may occur at any age. It is most frequently found at the lower end of the femur or the upper end of the tibia. Pathologic fracture occurs in 50 per cent of cases. Sequence of symptoms is pain, tumor, limp, trauma and fracture. The average duration of symptoms is slightly under one year prior to the initial treatment. Systemic symptoms are usually present, such as fever, leucocytosis and occasionally enlarged regional lymph nodes.

The lesion usually starts in the subcortical

region of the metaphysis but soon becomes central in location by rapid invasion of the cancellous bone and medullary spaces. Examination reveals a tense swelling without much reddening, which has a boggy feel and a slight suggestion of a semifluctuant nature. Pulsation may be present suggesting the bone aneurysm of the older literature.

Roentgenologic features:—The roentgenograms are extremely difficult to interpret. These lesions are confused with benign cyst, benign giant cell tumor, metastatic carcinoma, and Ewing's sarcoma by those experienced in roentgenologic diagnosis. The most important diagnostic feature is the central area of irregular destruction which extends through the unexpanded cortex, resulting in a periosteal reaction. The appearance differs somewhat, depending upon whether the lesion is early or late.

In the early cases the lesion is asymmetrically located because it is still subcortical. With a short duration of symptoms there is already a slight degree of cortical expansion, a melting away and perforation of the bone shell and the presence of a periosteal reaction. These features serve to distinguish it from the benign bone cyst with which it is likely to be confused.

In advanced cases, the marked osseous destruction and periosteal involvement make the diagnosis of malignancy relatively certain. A splintered and worm-eaten appearance and the degree of invasion into the soft parts, in a youthful patient distinguish this lesion from metastatic carcinoma and a focus of multiple myeloma which this tumor somewhat resembles roentgenologically.

A protracted form of osteolytic sarcoma occurring in adults is often confused with benign giant cell tumor. The tendency of this lesion to involve and expand the epiphysis with the presence of a definite periosteal reaction and perforation of the bone shell and a history extending over a period of from three to six years has given rise to this error in diagnosis. A number of these cases have been reported as metastatic giant cell tumors when the patients ultimately succumbed to metastases.

Gross pathology:—At exploration, there is found a vascular mass resembling a blood clot. Very active and profuse hemorrhage may occur. The bulk of the tumor is usually beneath the periosteum covered by a shell of cortical bone. Destruction of the medullary cancellous bone proceeds rapidly until the bone shell is perforated in one or more places after which the growth occurs chiefly in the less resistant soft tissues. White and firm fibrous areas enclosing secondary hemorrhagic cysts are characteristic. In advanced cases the entire shaft of the bone may be displaced with a white fibrous tumor tissue dotted here and there with hemorrhagic cysts.

Microscopic features:—This tumor is composed of tissue in which there are numerous blood spaces usually without endothelial lining surrounded by plump malignant spindle cells and round abortive osteoblasts. A characteristic feature is the hyperchromatism and the numerous mitotic figures indicating the high degree of malignancy of this lesion. Of importance is the finding of giant cells which has led to the confusion of this tumor with the benign giant cell tumor.

Certain features differentiate this tumor from other forms of sarcoma, thus the whorl formation of fibroblasts as seen in fibrosarcoma is absent, there is not as much new bone formation as found in the sclerosing osteogenic sarcoma, the absence of calcifying cartilage, myxoma and fetal cartilage distinguish it from the chondral forms of sarcoma and the ossification of tumorous origin and the large malignant osteoblasts serve to differentiate this lesion from angiosarcoma.

Histogenesis:—Microscopic evidence supports the view that this neoplasm represents an early phase of osteogenesis via fibrous tissue. Its location in the metaphysis where osteogenesis is most active and in the subcortical portion of the bone would definitely connect its origin with the endosteal form of ossification. Study of the human embryo reveals the significant fact that at the site of origin of osteolytic sarcoma newly formed vessels are prominent, and spindle cells and round cells of the osteoblastic type are abundant, a picture not far removed from that seen in the lesion under discussion. The failure of the osteolytic type of sarcoma to produce a state of adult bone is to be ascribed to the dependence of ossification in this type of tissue on the presence of calcified cartilage undergoing resorption. In the sarcoma there is an inadequate supply of calcified cartilage and the preosseous cellular tissue in the sarcoma readily outstrips the formation of osseous substance.

There is another group of osteolytic sarcomas

that are histologically of the same type and that occur in patients over thirty, in whom the outlook is not so grave and in whom the duration of symptoms dates back not months but years. This tumor is thought to arise upon some form of benign bone lesion such as the benign giant cell tumor, Paget's disease or an old fracture, and for this reason is referred to as a secondary form of osteolytic sarcoma.

Prognosis and treatment:—Of 87 cases of osteolytic sarcoma, 64 were followed for more than five years and of this number only 4 were living beyond five years. Three of these were over thirty years of age with duration of symptoms more than eighteen months. From this study it is concluded that only in the exceptional case in which the patient is an adult and the disease has run a protracted course and in which amputation preferably without irradiation is employed can favorable results be achieved. In younger patients the duration of life following treatment is about the same as the duration of symptoms, thus the course of the disease is usually somewhat less than two years. The similarity of the protracted forms of osteolytic sarcoma to secondary chondrosarcoma supports the inference that the more slowly growing and more readily curable instances of this disease are secondary to some preceding benign lesion.

The Sclerosing Form of Osteogenic Sarcoma

The most highly differentiated periosteal sarcoma is the osteoblastic or sclerosing type This is the most emphatic bone-forming tumor in the group of osteogenic sarcoma, it is the one with which clinicians and roentgenologists are most familiar, and which is most commonly diagnosed correctly as sarcoma of the bone. It is not the most frequent, however, ranking third, with 75 cases among a total of 360 osteogenic sarcomas forming the basis of this study.

Clinical features:—Among the clinical features of this group, the narrow age limits, the characteristic location and the brief duration of the symptomatology are outstanding. The majority of patients are between the ages of fifteen and twenty-five. Most of the lesions were situated in either the lower end of the femur or the upper end of the tibia, nearly 80 per cent of the tumors being thus accounted for. The most striking feature, however, is the region of the bone involved, being the metaphyseal side of the epiphyseal line. Duration of symptoms averages under ten months. Trauma was present in one-half of the cases, pathologic fracture is rare. Examination reveals a visible and palpable swelling of bony hardness near the end of the bone. Cutaneous changes are not marked over tumors of moderate size. In one-fifth of the cases leucocytosis or fever or both were recorded, which is about the usual incidence of these systemic reactions in rapidly growing malignant neoplasms of the bone whether the patients are seen in either the earlier or later stages of the disease. No particular diagnostic importance should be attached to such findings unless the temperature equals or exceeds 102° F., and the leucocytes 20,000; above these limits, infection is to be suspected.

Roentgenographic features:—The roentgen film furnishes the most helpful diagnostic data available to the practitioner in this group of cases. There is usually seen a dense formation of new bone obliterating the osseous markings in the metaphyseal region of a long bone. The medullary portion may be somewhat mottled, the result of secondary bone destruction. The periosteum above and below the main area of the tumor is raised and where it resumes its contact with the bone, a triangle of ossification appears, known as periosteal lipping. Although this so-called lipping has been much stressed as a diagnostic feature of sarcoma, it is not rare in forms of periostitis unrelated to neoplastic disease. The most striking feature in the roentgenogram is the radiating spicules of new bone proceeding outward at right angles which gives the characteristic shaggy, sun-ray appearance. In early cases, two to four months' duration, the lesion is seen to have its origin in the subperiosteal portion of the bone and comes to involve the cortex and medulla only in the late cases, six to twelve months' duration.

Gross specimens:—Examination of the gross specimens shows the metaphyseal origin of the tumor. In young patients with an unossified epiphyseal line, the cartilage walls off the tumor in that direction, and even in the advanced stages the epiphysis remains free while the growth extends instead outwardly into the soft parts and upward along the shaft. In older patients secondary involvement of the epiphysis occurs.

The tumor tissue is firm in consistency, varying in density from that of solid fibrous tissue to the hardness of compact bone. Its structure shows a definite grain or fiber which runs more

or less at right angles to the long axis of the bone. The color is white, light gray or whitish pink. There are no hemorrhagic areas or cysts. Invasion of the medullary cavity is apparently secondary to the subperiosteal growth and is always less in amount. The sclerosis of the medullary cavity is due to a combination of tumor and reactive bone. The picture of diffuse osseous consolidation seen in advanced cases caused the older pathologists to apply the name of sclerosing sarcoma to this new growth.

Microscopic features:—Microscopic studies confirm the view that the neoplastic process in this sarcoma involves tissue concerned in direct osseous formation. The histology of all these lesions is essentially a proliferation of connective tissue passing through the stages of spindle cells, osteoblasts, osteoid tissue and new bone. The osteoblasts and osteoid tissue are present in a disorderly fashion and differ considerably in appearance as seen in benign osseous formations.

Histogenesis:—The evidence accumulated in this study leaves little doubt as to the source of this form of osteogenic sarcoma. The tumor takes its origin in the osteogenic layers of the periosteum which are particularly active in the formation of compact bone in the metaphyseal region of young adults and children in the preadolescent period. This active ossification is not found in the epiphysis after the age of three or in the midshaft region after birth, accounting for the absence of this type of sarcoma in these regions. However, the mechanism whereby the normal type of growth and histogenesis are transformed into the disorderly and malignant histologic cycle typical of carcoma is obscure. Although trauma is recorded in 50 per cent of these lesions, no direct connection can be traced between the immediate result of the injury and the subsequent malignant response.

Prognosis and treatment:—Cures effected by radical operation are unusually frequent in this type of sarcoma. In 60 cases, followed over a period of five years, there were 16 cured patients living five years or longer. All cures were effected by radical operation, amputation being performed when possible and radical resection in cases affecting the clavicle or rib. These data leave no question as to the procedure of choice in this type of sarcoma. If facilities for frozen section are not available and consultation is required in the diagnosis, the roentgenograms and not the sections should be sent, as a diagnosis can usually be obtained roentgenologically without the necessity of exploration if the proper authorities are consulted. Deep roentgen therapy does not result in cure in these cases and only restricts the rate of advance of the peripheral margin of the lesion.

In regard to the prognosis, the chances of cure are more than 25 per cent if primary radical operation is performed. Patients surviving radical operation after eighteen months, who show no signs of recurrence or metastases at that time, will, in all probability, remain free from disease. The high percentage of cures in this tumor is dependent on the state of differentiation of the malignant cells or osteobalsts which represents the apex of development in the derivation of bone from connective tissue. This favorable prognosis is in keeping with the general rule that the higher the state of differentiation in the neoplastic tissue, the less malignant is the clinical course.

Variants of the Sclerosing Form of Osteogenic Sarcoma

There are a number of lesions in this group which differ somewhat from the more or less typical sclerosing sarcoma. About one case in five will show small islands of cartilage which is no doubt derived from persisting remnants of the primitive perichondrium. These lesions differ in no other respect from the characteristics of the parent group.

Of more importance is the mixed spindle and round cell variant. There is no satisfactory way to classify this small group clinically. In the roentgenogram they resemble a primary chondrosarcoma, in the gross and microscopic specimens they duplicate features of the osteolytic variety of tumor, and from a histogenetic standpoint they are closely allied with the sclerosing form.

Secondary sclerosing sarcoma:—There are a number of cases in this group of sclerosing sarcoma, a study of which indicates that the malignancy is secondary to an original primary and benign lesion. In 2 cases malignancy occurred in the callus of an old fracture while in 2 other cases a benign myositis ossificans was the seat of the neoplastic process. These proved instances of sclerosing osteogenic sarcoma arising secondarily to benign lesions are in keeping with the evidence studied in regard to the other forms of osteogenic sarcoma, namely, the chondrosarcoma and osteolytic variety both of

which may arise as primary or secondary lesions.

Conclusions Concerning the Fibro-osseous Forms of Osteogenic Sarcoma

In contrast to the chondral forms, the fibro-osseous tumors may achieve from the histogenetic standpoint a high degree of cellular differentiation, the sclerosing sarcoma representing the end-point in this respect. It is therefore the least malignant and presents a fair degree of curability. It can be concluded from the analysis herein presented that a different type of tumor is possible for each phase of the histogenesis of bone.

Conclusions and Clinical Applications

The separation of osteogenic sarcoma into separate forms based on the individual phases of osteogenesis involved is not a theoretical attempt to arrive at the etiology of sarcoma, but is a serious endeavor to comprehend the behavior of these growths in their clinical aspects, although it cannot be denied that this analysis sheds a decided light on the nature of the malignant process in bone.

Some of the more important conclusions are herein summarized.

Significance of a protracted history:—The current conception of the typical sarcomatous history met with in patients suffering from malignant disease of the bone is in need of definite revision. A youthful patient and a brief acute clinical course are not indispensable to the diagnosis, and it can no longer be claimed that a prolonged history and advanced age rule out this dread disease.

Interpretation of roentgenograms:—The fundamental basis of interpreting lesions of the bone in the roentgenogram is also in need of revision. It is necessary to pass beyond the reliance placed on mere configuration and analyze the film as a dynamic record of both normal osteogenesis and a malignant perversion of some phase of this osteogenesis. The fact that an osteogenic sarcoma may at times be predominantly a periosteal lesion and at other times, predominantly central, emphasizes the necessity of interpreting the roentgenogram in relation to the phase of osteogenesis involved by the tumor rather than attributing these contrasting pictures to chance or an indefinable complexity.

Coordination of clinical and pathologic findings:—A more complete coordination between the clinical and pathologic picture is made possible by this factoring of the various forms of osteogenic sarcoma. Thus it is possible to understand the presence of giant cells in certain of these tumors, the status of myxomatous tissue in chondromyxosarcoma is established, and the production of malignant bone of sclerosing sarcoma is differentiated from normal reactive bone laid down in benign inflammatory conditions and osteitis fibrosa.

Grading of osteogenic sarcoma:—For the first time a fairly reliable grading of the degree of malignancy of sarcomas of the osteogenic group is made possible, and the prognosis rendered more than a shrewd guess. The clinical aspects of the lesion, including the roentgenogram, may be used in conjunction with the microscopic picture to grade these neoplasms. When the most advantageous treatment is used, from 5 to 10 per cent of permanent cures is the base line. From this minimum the chances of cure are increased fivefold, if the lesion arises as a secondary malignant change or if the tissue of origin is of the highly differentiated sclerosing form.

Indications for irradiation:—Taken as a group, it is impossible to state whether or not the osteogenic sarcomas are radiosensitive, and unless these tumors have been analyzed on a histogenetic basis, this matter cannot be decided. From the present study, however, it can be concluded that the forms of osteogenic sarcoma arising from precartilaginous connective tissue and cartilage show definite evidence of being relatively radiosensitive, and those tumors of the fibro-osseous series are relatively radioresistant. At the present time, radium therapy has achieved better results than deep roentgen therapy in the chondral forms of sarcoma. There is no difference in the ultimate result whether treated by irradiation pre- or postoperatively. It is important to emphasize that in none of the forms of osteogenic sarcoma can it be proved that irradiation alone suffices for a permanent cure. When irradiation has been tried over a period of one month as the initial form of treatment without definite and striking results, surgical measures should be promptly instituted.

Etiology:—From this study it may be concluded that a normal and active center of tissue differentiation constitutes a predisposing cause to the formation of tumor. This conception en-

larges the insufficient embryonic theory of Cohnheim, recognizing that histogenesis in the tissue is not confined to the embryo, but occurs in all normal structures at various periods throughout life. An important corollary to this histogenetic conception of neoplasms is that the variety of etiologic factors proposed for malignancy—trauma, infection, chronic irritation, metabolic or endocrine imbalance, etc.—must be looked on as precipitating agents only for these new growths.—*Karl Kornblum.*

DEL BUONO, PIETRO. Alterazione dello scheletro nell'emo-angiosarcoma della milza. (Changes in the bones in hemangiosarcoma of the spleen.) *Radiol. med.*, June, 1932, *19*, 609–630.

A case of primary hemangiosarcoma of the spleen in a woman of fifty-two is described. Roentgen examination showed zones of rarefaction due to decalcification in the bones of the skull, spinal column and pelvis. These changes were distinctly different from those seen in other tumors of the spleen. This is the first case of primary hemangiosarcoma of the spleen in which bone changes have been described.—*Audrey G. Morgan.*

DIDIÉE, JEAN. Semiologie radiologique de la rotule. (Roentgen symptomatology of the patella.) *Acta radiol.*, 1932, *13*, 144–164.

Plates are given showing roentgenograms of the various pathological conditions seen in the patella. The picture most frequently seen is that of division of the bone. In most cases this division is caused by fracture but it may be a bipartite patella caused by anomalies in ossification. A differential diagnosis between fracture and bipartite patella may be made from the form, situation and direction of the line of cleavage, in addition to the clinical symptoms. There may also be tumors of the patella, either true osteomas which may be median or lateral or ossifications of the tendons; also intra-articular foreign bodies of the mucous bursa beneath the quadriceps. Infections, tumors and trophic disturbances of the patella are the same as those seen elsewhere, though special mention may be made of traumatic patellitis, which is an osteoporosis caused by trauma.—*Audrey G. Morgan.*

SANTORO, MARIO. Alterazioni pagetiche dello scheletro di una malta portatrice di grosso fibromioma calcificato. (Paget's disease in a patient with a large calcified fibromyoma.) *Radiol. med.*, July, 1932, *19*, 712–717.

A woman aged fifty-six came for examination for pain in the right coxo-femoral joint. Roentgen examination showed an opaque mass the size of an orange in the pelvis which proved to be a calcified fibromyoma. The patient had begun to suffer with diffuse rheumatoid pain about fifteen years before, followed by deformity of the bones of the face and skull and difficulty in walking. On examination she could not stand on account of intense pain in the left coxo-femoral joint. She showed dorsal kyphosis, her head was large and sunk between the shoulders. In contrast with the enlarged skull bones the bones of the face were small. The thorax was partially flexed on the abdomen.

The Wassermann reaction was negative. Blood calcium was higher than normal. Roentgen examination showed irregular areas of increased density of the bones, particularly the tibias and fibulas and the bones of the skull and pelvis, the favorite sites of Paget's deforming osteitis. There was no traumatic lesion of the left coxo-femoral joint but the interarticular line was profoundly changed by the bone disease of the region. The sella turcica was not deformed. It was turned a little upward and backward by the changes in the skull bones. There was probably some process of arteritis or arteriosclerosis which caused both the Paget's disease and the calcification of the tumor.—*Audrey G. Morgan.*

PACINI, DANILO. Tubercolosi dell'olecrano. (Tuberculosis of the olecranon.) *Radiol. med.*, July, 1932, *19*, 708–711.

A case of tuberculosis of the olecranon which did not invade the joint is described in a man aged twenty-seven. He had had hemoptysis at the age of twenty-four. Examination on admission showed tuberculosis of the lungs and a fistula just above the olecranon of the left elbow. The author thinks this isolated tuberculosis of the olecranon may have been brought on by occupational trauma as the patient was a draughtsman and drummer in a jazz band. In his work as draughtsman he frequently leaned his left elbow on the table to hold his work down and as drummer the extensors of the forearm were fatigued. As it was a circumscribed focus that had not yet involved the joint the author performed a partial resection of the olecranon which brought about cure

with complete restoration of the movements of the arm.—*Audrey G. Morgan.*

Funston, Robert V. The relation of congenital deformities of the hand to cervical ribs. *J. Am. M. Ass.*, Feb. 27, 1932, *98*, 697–700.

Several authors have reported cases of congenital deformity of the hand and forearm with absent or rudimentary radii but no previous mention has been made of its association with anomaliesof the cervical spine. Six cases are presented from the author's practice all of which had cervical ribs. Schrock and Gaenslen added 2 additional cases with club hand and cervical ribs.

Operative procedures in 3 of the above cases resulted in definite improvement in function. Surgical correction should be more satisfactory if done early as the greater part of the bone growth seems to come early in life. The ulna of the mother of one case was approximately of the same length as that of her nine year old daughter, the two presenting almost identical deformities.—*E. W. Hall.*

Burlingame, R. M. The diagnosis of diseases of the hip-joint. *Am. Rev. Tuberc.*, Jan., 1932, *25*, 32–41.

This paper is a résumé of the diagnosis and treatment of hip joint diseases.

Tuberculosis of the hip usually invades the upper femoral epiphysis in children and the head of the femur in adults. The synovial type is rare in the hip. Roentgen examination shows irregular necrosis near the epiphysis in the early stages. This gradually undermines the cartilage and superficial bone until the joint is invaded. Later there is erosion and destruction of the articular cartilage and adjacent bone. The acetabulum may be destroyed and the head of the femur dislocated. Abscesses are a late manifestation. In children the symptoms of morning stiffness, limp, pain occasionally in the hip but always referred to the knees, and night cries are the usual symptoms. Atrophy is constant and occurs early. Induration and swelling are later manifestations. After extensive destruction there is organic deformity with flexion, adduction and internal rotation. Early tuberculosis of the hip is rarely seen in adults. It begins insidiously with less acute symptoms than in children.

Legg's disease, or coxa plana, occurs between the ages of five and ten. No specific etiology has been proved. Little is known as to the pathology. The roentgenogram shows flattening of the head of the femur with mild destructive changes in the acetabulum and increase of the diameter of the neck. Later fragmentation of the epiphyseal disc occurs and results in a broad, flat head. A slight limp with mild pain are the only common symptoms.

Coxa vara defines a clinical entity also called separation of the upper femoral epiphysis which occurs between twelve and eighteen years of age. Endocrine imbalance is a predisposing cause but normal individuals may be affected. The roentgenogram shows a separation of the epiphysis with upward displacement of the neck. Constitutional symptoms are absent. There is a slight limp or shortening. In bilateral cases a characteristic waddle is noted.

Acute infectious arthritis is the most frequent destructive disease of the joints. It is due to an acute inflammation from pyogenic bacteria. The eventual destruction and ankylosis depends upon the severity of the infection. In children partial or complete obliteration of the epiphyses is not uncommon. Under eight years, ankylosis is usually fibrous. The onset is typical of an acute infection, as are the localizing symptoms. Early dislocation from distention of the capsule may be seen by roentgen examination.

Acute transient epiphysitis occurs under ten years of age in active children. The symptoms localize promptly in the hip. Systemic reaction is that of a mild infectious process. The roentgenogram is not altogether diagnostic.

Differential diagnosis of the diseases of the hip is most difficult between tuberculosis and infectious arthritis. No one means of diagnosis should be relied upon to the exclusion of others.

Treatment of tuberculosis is now chiefly by heliotherapy and extension. Plaster casts have been abandoned. Acute infectious arthritis responds to drainage with correction of deformity by traction. Coxa plana requires eradication of foci of infection, casts and possibly operation for deformity. Coxa vara requires treatment of possible endocrine disturbance and reduction of deformity either by the closed or open method. Three cases are presented.—*G. R. Miller.*

Finsen, V. Two peculiar cases of bone tuberculosis. *Acta radiol.*, 1932, *13*, 264–268.

The author describes 2 cases of bone tuberculosis in which the roentgen pictures were very

unusual. The first was in a young man who twenty-one months previously had suffered a trauma of the right elbow from a fall. Roentgen examination immediately afterward showed sequestration of the medial epicondyle of the humerus. He recovered except for some limitation of the movements of the joint. About a month ago he suddenly began to have pain in the elbow and a fistula developed on the dorsal surface of the joint from which pus was discharged. There was a large tumor of the joint in the form of spicules of bone. The clinical picture of the case was that of tuberculosis and histological examination of the specimen after arthrotomy showed that the change was tuberculous. Mixed infection may have been responsible for the enormous periosteal tumor.

The second case was in a boy of three who had been well until a week before his admission to the hospital when he began to complain of pain in his left forearm which was swollen. He had slight inflammation of the glands of the neck. There was a round swelling of the proximal half of the ulna. The skin looked natural; there was no fluctuation. Wassermann negative; Pirquet 3 plus. The roentgen picture showed an enormous spindle-shaped swelling of the diaphysis of the left ulna which proved to be a stratified periosteal new growth. In the center, corresponding to the original diaphysis, there was a slightly irregular rarefaction. The picture resembled that of staphylococcic osteomyelitis. Histological examination of the loose granulation tissue found between the periosteum and the cortex showed tuberculosis. Later a similar growth developed in the distal end of the right fibula.—*Audrey G. Morgan.*

BIDOLI, EMILIO. L'artrite costo-vertebrale. (Costovertebral arthritis.) *Radiol. med.*, April, 1932, *19*, 406–409.

A case is reported in a man of twenty-eight who had suffered contusions of the vertebral spinal column from a fall. He said that for about a year before the accident he had had pain in the nape of the neck and interscapular region which extended sometimes to the base of the lungs. This dull pain was aggravated when he was obliged to carry things on his shoulder. Examination of the spinal column and thorax did not show any special injuries that could be attributed to the trauma. But there were exostoses in the form of little tongues of bone at the costovertebral articulations of the 4th, 5th and 6th cervical vertebrae on the right and the 4th and 5th on the left. The joint interline of these joints was irregular, rough and jagged.

The clinical symptoms of costovertebral arthritis are vague and the only means of definite diagnosis is by roentgen examination. This serves to differentiate the disease from other conditions of the lungs, pleura and vertebral column which might otherwise be confused with it.—*Audrey G. Morgan.*

FARRELL, JOHN T. JR., and BURT, EDWARD F. Nonrachitic cupping of long bones in the new-born; a roentgenologic and clinicopathologic study. *J. Am. M. Ass.*, May 21, 1932, *98*, 1801–1803.

The question of congenital rickets has been much discussed. Hess, Weinstock, Pommer and Schmorl were unable to find definite evidence of rickets in the new-born. In some cases cupping of the diaphyses of long bones is present roentgenographically without other evidence of disease. The authors studied a group of 48 negro children during the first two days of life. Seven showed abnormal cupping of flange formation and subsequent studies seemed to bear out the belief that this was due to rickets. However, in a series of roentgenologic and histologic studies of still-born infants cupping was found to be an anatomical variation and no microscopic evidence of rickets was present. The conclusion is that roentgenographically recognizable cupping in the ends of the long bones of new-born infants is sometimes present as a normal occurrence.—*E. W. Hall.*

HEISE, AGNETE. On the identity of imperfect congenital osteogenesis and idiopathic osteopsathyrosis, and on the diagnosis of the latter from infantile scurvy. *Acta radiol.*, 1932, *13*, 319–328.

The author describes a case of imperfect congenital osteogenesis and refers to 4 other cases in which this disease was associated with leptosclera. He proposes substituting this name for blue sclerotics because the latter suggests actual coloring of the sclera while leptosclera describes the true condition which is an extreme thinness of the membrane. In 2 of these cases there was undoubted evidence of heredity, as the patients were mother and daughter. All these cases tend to confirm the theory that imperfect congenital osteogenesis and idiopathic

osteopsathyrosis are the same disease and the author thinks, in accordance with Looser's suggestion, that the disease should be called late imperfect osteogenesis.

He then describes a case of fragility of the bones in a couple of male twins three months old as being particularly interesting from the point of view of differential diagnosis. The history, the course of the pathological process and the roentgen changes seen in the epiphyses of the long bones at the end of the disease indicated that this was an infantile scurvy. The author attributes the fractures of the shafts to osteopsathyrosis due to avitaminosis which has been described by Czerny and Keller; it may occur alone or in association with other diseases. After the scurvy was cured the children developed rickets, but there were no further fractures in this disease.—*Audrey G. Morgan.*

Pemberton, Ralph, and Peirce, E. G. The relation of the intestinal tract and diet to the treatment of arthritis. *Ann. Int. Med.*, April, 1932, *5*, 1221–1237.

The writers have been impressed by the frequency with which anatomical, topographical and physiological abnormalities of the intestinal tract can be demonstrated by roentgen-ray study in arthritis. Under appropriate conditions of diet these abnormal configurations, chiefly of the large bowel, return toward or to normal. This abnormal condition is probably of etiologic and pathologic importance and any therapeutic effort must include consideration of this phase of the problem. Emphasis is placed on the large bowel to the relative neglect of the small due to the fact that detailed study of the latter is not possible with present roentgen technique. The stomach and gallbladder admittedly share in the deviations of the intestinal tract as a whole.

Twelve cases of chronic arthritis showed more or less return of the large bowel to normal following successful treatment of the arthritis. The treatment adopted included modes in which dietetics, removal of focal infection and physiotherapy were respectively dominant.

The conclusion is drawn that the abnormal contour of the bowel encountered in arthritis is one consequence of the disease in general, whatever its etiology. Thus, once established, the abnormal contour, and presumably abnormal function, of the bowel becomes an additional contributory or causative factor in perpetuating the disease. Arthritis may thus be originated by an infection, the removal of which in no way influences secondary consequences of this nature. It is equally probable that the configuration and dysfunction of the intestinal tract constitute an originally exciting factor in the production of the disease.

Part two of the article deals with the favorable influence of low caloric diet with all vitamins excluded upon both the atrophic and hypertrophic types of arthritis. The relation of food intake and the intestinal function are reciprocally concerned, the institution of an appropriate dietary affording a fundamental approach to the adjustment of the labors of the intestine. Adequate evacuation, especially by means of colonic irrigations, is considered important. The propriety of such a dietary regimen should be independently determined and applied to appropriate cases only.—*W. R. Brooksher, Jr.*

Hellmer, Hans. Röntgenologische Beobachtungen über Ossifikationsstörungen im Limbus Vertebrae. (Roentgen observations on disturbances of ossification in the borders of the vertebrae.) *Acta radiol.*, 1932, *13*, 483–517.

The upper and lower borders of the vertebrae have separate centers of ossification and do not unite with the rest of the body of the vertebra until the age of seventeen to twenty-five years. The author describes and illustrates 13 cases in which disturbances of ossification had led to a failure of a part of this limbus or epiphysis of the vertebra to unite with the rest of the body, giving a characteristic roentgen picture. There was a defect of varying size in the body of the vertebra, which in all cases seen so far was on the anterior circumference of the limbus and most frequently in the lumbar column, and next most frequently in the lower part of the dorsal column. The greater part of the defect was filled with a bone fragment which in lateral roentgenograms was the shape of a sickel or a segment of a circle. The size of the fragments was quite constant but there were some exceptions, just as there are variations in the epiphyseal centers of ossification of the vertebrae. The surfaces of the fragments and of the body that were turned toward each other were generally smooth or, with a certain incidence of the rays, wave-like, which is a point in differentiation from fracture fragments, which have an irregular border.

Very little is known about the cause of these disturbances of ossification. The roentgen picture is sufficiently characteristic so that these fragments can be differentiated from bone deposits in the anterior part of the intervertebral discs and from fractures in the bodies of the vertebrae.—*Audrey G. Morgan.*

ZANGHERI, CARLO. Sulla rara via di migrazione di un ascesso ossifluente di origine vertebrale. (Unusual route of migration of a bone abscess originating in a vertebra.) *Radiol. med.*, Aug., 1932, *19*, 865–869.

The author describes a case in a man aged twenty who had a tuberculous abscess of the 9th and 10th dorsal vertebrae. He also had a small fistula in the sternocleidomastoid muscle on the left side of the neck which was discharging pus that appeared to be tuberculous. In order to study the course of the fistula an injection of opaque medium was made into it. During the injection the patient had a violent attack of coughing which suggested communication with the trachea or a bronchus. Roentgen examination showed that pus had risen from the vertebral abscess to the level of the 4th cervical vertebra, crossed to the opposite side of the spinal column, ruptured into a bronchus and caused the fistula of the neck. This is a very unusual case and still more unusual from the fact that this course of the pus had not caused any symptoms.—*Audrey G. Morgan.*

BLOOD AND LYMPH SYSTEM

BAASTRUP, CHR. I. Subcutaneous calcifications of a phlebolithic or phlebosclerotic character in the leg. *Acta radiol.*, Aug. 15, 1932, *13*, 206–212.

Roentgenograms are given of phleboliths of the leg and of calcified phlebosclerosis and of cases in which both these conditions existed at the same time. In one case the calcifications had developed to such an extent as to form a hard cuff around the cone of the leg muscles. The lumina of the vessels were so large as to indicate either that the veins had become dilated or that the calcareous elements had forced their way out through the walls or that the process of calcification had spread to the tissue surrounding the veins, or that two or all three of these processes had taken place together. The author does not think that calcification and phleboliths of the leg are exceptional though little attention has been paid to them in the literature. More attention should be given to them because of their importance in the modern injection treatment for varicose veins.—*Audrey G. Morgan.*

BARBER, T. H. T., and ORLEY, A. Some x-ray observations in varicose disease of the legs. *Lancet*, July 23, 1932, *2*, 175–176.

This paper relates the results obtained by study of varicose disease of the leg by means of the injection of abrodil and stereoscopic roentgenograms. The study is summarized as to: (1) the rate and direction of the venous blood stream in (*a*) normal, (*b*) varicose conditions, and (2) the anatomy, physiology and pathology of the veins of the leg and of their valves in (*a*) normal, (*b*) varciose conditions. Ten c.c. of a 10 per cent solution of abrodil was injected into the vein just prior to each exposure of the stereoscopic pair. The studies demonstrated: (1) The normal internal saphenous vein showed a slight dilatation at the level of the internal condyle of the tibia, corresponding with a constant valve in this situation. In varicose veins large ampullary dilatations were occasionally seen at this level. (2) In normal veins the fluid flowed toward the heart. Its backflow was stopped by the first valve below the site of injection; in varicose veins the flow was both backward and forward. The backward flow was due to incompetence of the valves. (3) In the normal vein none of the solution was seen to enter the deep circulation of the leg through communicating or anastomosing vessels. In a few cases of varicose veins the opaque fluid was seen to penetrate into the deep circulation through anastomotic vessels at the level of the ankle and knee-joint, but never through the venae comites. (4) The rate of flow in both normal and pathological cases was influenced by posture, rest, muscular activity and respiration. (5) Roentgenology of the veins may be of considerable assistance in cases which do not respond to the usual injection treatment.—*W. R. Brooksher, Jr.*

MULLER, GULI LINDH, and MCNAUGHTON, ELIZABETH. Multiple myeloma (plasmatocytomata) with blood picture of plasma cell leukemia, report of two cases. *Folia Haematol.*, 1931, *46*, 17–25.

From the literature it appears that cases of multiple myeloma with evidence of the entry of large numbers of plasma cells into the pe-

ripheral blood are rare. Two such cases are reported. They seem to support the theory that myelomata and plasmocytomata are diseases of the hematopoietic system with all gradations existing between multiple tumors confined to the bone marrow alone and a generalized systemic disease with plasma cell infiltration throughout the organs as well as in the peripheral blood. Multiple myeloma may, according to some authors, originate in extra osseous tissues with subsequent involvement of bone marrow.—*E. W. Hall.*

Menville, Leon J., and Ane, J. N. Roentgen visualization of lymph nodes in animals. *J. Am. M. Ass.*, May 21, 1932, *98*, 1796–1798.

While conducting experiments on animals by injecting thorium dioxide into the tail veins of rats it was found that if the chemical was introduced into the perivascular lymph spaces its presence could be demonstrated in the regional lymph nodes after one to three days. This observation has both diagnostic and therapeutic significance. In radical operations for neoplasm it would be of considerable advantage to the surgeon to know the exact location of affected nodes. The possibility that the presence of thorium in neoplastic glands would render them more susceptible to radiation therapy is entertained and is to be the basis for further study. It may be that thorium rays alone might produce destruction of cancer cells and fibrosis. This is also being investigated.—*E. W. Hall.*

Piney, A., and Riach, Jean S. Multiple myeloma; aleukaemic and leukaemic. *Folia Haematol.*, 1931, *46*, 37–58.

Three cases are presented in considerable detail and discussed with a view to classification and differential diagnosis. Four modes of manifestation of multiple myeloma are described: (1) the commonly accepted form of Kahler's disease with multiple skeletal tumors and no striking blood changes; (2) cases with growth in bone and other tissues with a few plasma cells in the peripheral circulation; (3) cases with less bone destruction but with diffuse infiltration of marrow and many other tissues and a high percentage of plasma cells in the blood; (4) cases with generalized diffuse infiltration of marrow, histologic changes resembling lymphatic leucemia in all organs and large numbers of plasma cells in the blood. Bence-Jones bodies are variably present in the urine, being reported in 42 of 118 cases. One of the authors' cases shows marked parathyroid hypertrophy. The authors discuss etiology, themselves apparently favoring the view that the disease is of neoplastic origin.

Roentgenographically, multiple myeloma must be differentiated from metastatic carcinoma. In multiple myeloma the growth starts in the endosteum and later there is a concentric thinning over a very large area. Compact bone is only slightly eroded and fractures occur in areas apparently no more eroded than adjacent portions. Extension to surrounding tissues is greater in late stages of multiple myeloma but accompanied by less destruction than carcinoma. Carcinoma produces more localized and more destructive bone lesions with fracture at the point of greatest destruction.—*E. W. Hall.*

Swanson, Leonard A. Aleukemic, myelogenous chloroma. *Am. J. Dis. Child.*, July, 1932, *44*, 140–145.

Earlier observers considered chloroma as lymphogenous, but since the advent of the oxydase reaction, most investigators have come to regard it as being myelogenous. Swanson reports a case of chloroma in a girl two years of age, terminating in death within sixty-eight days after the onset of symptoms. Profound anemia was present when the patient was first seen, twenty-three days after the onset of symptoms, and progressed in severity to the time of death. Roentgenograms of the long bones taken one month after the onset of the disease did not indicate a generalized involvement of the bone marrow. Repeated examinations of the blood failed to disclose any leucemic changes. The tumor was primary in the bones of the skull, with early exophthalmos, and metastases were present in the lymph nodes, ovaries and suprarenals. Both the primary and the secondary tumors gave a strongly positive oxydase reaction. The characteristic green color was obscured in the primary tumors by necrosis and hemorrhage, but was typical in the metastases.

Roentgen therapy was instituted within a month after the onset of symptoms, with no beneficial results. It consisted of one-half an erythema dose to the left temporal region. This was repeated two days later to the right temporal area and sixteen days later the same dose was given over the abdomen. Following the

first treatment there was a slight transient diminution in the exophthalmos and in the palpebral edema.—*R. S. Bromer.*

ROENTGEN AND RADIUM THERAPY

HOLTHUSEN, H. Die biologischen Grundlagen der Langzeitbestrahlung. (The biological principles of protracted irradiation.) *Strahlentherapie*, 1931, *42*, 881–898.

Coutard has introduced a method of protracted irradiation in which many partial doses are given and a much higher total dose attained without injury than by the method of single dosage. It was at first thought that the quality of the action of the rays depends on wave length but this was found not to be true. This increases the importance of the time factor in dosage. A study of the influence of the time factor has shown that as the total irradiation time is increased the cumulation of the total dose is less complete. The living cell is able to recover from the action of the rays. Kingery determined the doses that have to be given at varying intervals after a preceding irradiation in order to produce a skin reaction of constant intensity. He found that the longer the time since the first irradiation, the larger the dose had to be to produce the same effect. Using these values he worked out a logarithmic curve which he calls the recovery curve.

The influence of the time factor varies with different biological objects and even in the human subject it has different effects on different kinds of tissue. Experiment has shown that by the protracted fractional method a given amount of irradiation has the same effect on the tumor with less injury of the normal tissues, particularly the vascular connective tissue, than single irradiation. And more intense reactions can be brought about in the skin without injury than could be borne by the single dose method. Reactions that are comparable to burns of the second degree heal very quickly. The regenerative capacity of the mucous membrane after fractional irradiation is also very great.

This greater reactive capacity of the skin and mucous membranes shows that with the protracted fractional method the vascular connective tissue is relatively little affected. As the irradiation time is lengthened the electivity increases. The cumulation of the total dose is more incomplete and recovery more rapid the lower the individual dose lies beneath the limit of tolerance for the tissue in question.

Protracted fractional irradiation is particularly indicated in regions in which there is great danger to the vascular connective tissue, as for instance in tumors of the larynx. These have been practically hopeless by the old methods but the results have been greatly improved since the introduction of Coutard's method.—*Audrey G. Morgan.*

v. KÉMERI, D. Eine neue indirekte Röntgenstrahlenmethode zur Behandlung der Dyshidrose und gewisser Ekzemfälle. (A new indirect roentgen method for the treatment of dyshidrosis and some cases of eczema.) *Strahlentherapie*, 1932, *43*, 597–600.

In most cases of dyshidrosis there are latent foci of infection somewhere in the body. By irradiating such foci the author suceeded in curing the dyshidrosis. The same is true in eczema, except that the foci are not so easy to find. The author has, however, used roentgen provocation of the latent foci successfully in some cases of eczema also. In some cases nothing could be found but slight and apparently insignificant foci at the hila of the lungs. These were irradiated in cases in which there were no other pathological processes in the lungs. In 2 cases the eczema was cured within fourteen days after the irradiation though it had persisted for two years before. In 4 cases the process flared up five to ten days after the irradiation. These cases were treated with tuberculin and arsenic. The eczematous process apparently heals parallel with calcification of the foci.—*Audrey G. Morgan.*

BIGNAMI, G. Die Radiotherapie der Blutkrankheiten. (Roentgen therapy of blood diseases.) *Strahlentherapie*, 1932, *43*, 43–67.

Among the primary blood diseases there are parenchymatous forms which include the leucemias, erythemias, myeloma and chloroma, and strumatous forms, such as malignant granuloma. The former require cautious treatment with small and moderate doses of rays while the latter require moderate or large doses. Among the parenchymatous diseases the forms in which the white cells are chiefly injured respond very well to roentgen treatment while those in which the red cells are involved are very resistant to the rays.

It is impossible to give any routine method of treatment and even in the individual case the treatment cannot be uniform from beginning to end but must be adapted to the changes in the clinical condition and blood picture. In some of the blood diseases there are absolute indications for roentgen treatment and in others only symptomatic indications. Among the former are the leucemias, malignant granuloma, lymphosarcoma and polycythemia. Roentgen treatment is not as effective in the acute as in the chronic forms. In the latter it improves the general condition and blood picture and lengthens life. Needless to say, the treatment requires experience and skill on the part of the roentgenologist.—*Audrey G. Morgan.*

Giese, E., and Ossinskaja, W. Weitere Beobachtungen über die Röntgentherapie der Syringomyelie. (Further observations on roentgen treatment of syringomyelia.) *Strahlentherapie*, 1932, *43*, 739–748.

Since 1924 the authors have treated 128 patients with syringomyelia by roentgen therapy at the State Institute for Roentgenology and Cancer Research of Leningrad. They conclude that roentgen therapy is the treatment of choice in syringomyelia. No other method of treatment gives such a high percentage of improvements in the objective symptoms of the disease. There was permanent improvement in the chief symptoms of the disease in about 50 per cent of the cases, in 20 per cent the disease progressed and in the other 30 per cent it became stationary. Fresh cases gave a larger percentage of good results than older ones, as a rule, but there were some old cases that responded better than the fresh ones. In all probability this depends on the nature of the pathological process in the individual case—on the presence of gliosis or cavities. If there are cavities not much can be expected from roentgen treatment. There was particularly good improvement in the trophic symptoms, such as rapid healing of wounds, absorption of joint effusions and healing of fistulas. There was greater improvement in skin sensation than in motion. Tactile and pain sensations improved in the majority of cases sooner than pain sensation. Pareses of the lower extremities were improved in a greater percentage of the cases than pareses of the upper extremities because the pyramidal tracts react better to roentgen rays than the motor cells of the cervical enlargement of the cord.

Though the clinical picture of syringobulbia is severer than that of syringomyelia it improves more rapidly under roentgen treatment and some of the bulbar symptoms are cured completely. The good effect of roentgen therapy in syringomyelia is due to the destructive action of the rays on glious tissue. As the process in the brain stem generally develops later than that in the cord, syringobulbia is generally a fresher process than syringomyelia and therefore reacts more readily.—*Audrey G. Morgan.*

Schröder, Robert. Methoden und Erfolge der Krebsbekampfung in der Gynäkologie. (Methods and results of cancer treatment in gynecology.) *Strahlentherapie*, 1931, *42*, 858–869.

The cure of cancer does not concern the state immediately, as does that of tuberculosis and syphilis, for it is not infectious. But cancer of the female genitalia breaks up family life and deprives many children of the care of a mother at an age when they most need it and for that reason state aid in the treatment of cancer seems justifiable. Among 768 cases of cancer of the female genitalia which the author saw from 1923 to 1930, 585 were of the cervix. About 50 per cent of the cases of cancer of the cervix are inoperable when they come for treatment. This figure should be improved by instruction not only of the public but of the physicians. Women should be taught that if they have a discharge or hemorrhage they should go to a physician for examination. In Schleswig-Holstein nurses, social workers and midwives are being instructed to talk to the women with whom they come in contact about these symptoms and advise examination. More thorough instruction must also be given to physicians in recognizing the early symptoms of cancer.

The methods of treatment of cancer of the cervix are Wertheim's radical abdominal operation. Schauta's total vaginal extirpation, and radiotherapy. About 20 per cent of the women treated are alive after more than five years. Doubtless if patients can be brought to operation earlier the figures can be improved. And it is possible that further improvement may be brought about by suitable combinations of operation and preoperative and postoperative irradiation.

The majority of recurrences occur in the first year; the author's own material shows 50 per cent of the recurrences in the first year and 25 per cent in the second. Coutard's protracted fractional irradiation has proved effective in treating recurrences. The author has treated 32 cases of recurrence with radium alone or a combination of radium and roentgen treatment with cure in 12 for from nine months to four years. Patients should be regularly examined after operation at intervals of three to four months to detect any recurrence early.

More is to be expected in the management of cancer from organization and cooperation among all the different groups interested than from advance in scientific knowledge of the disease.—*Audrey G. Morgan.*

SIMON, STEFAN. Die Bestrahlungsergebnisse beim Carcinoma vulvae. (The results of irradiation in carcinoma of the vulva.) *Strahlentherapie*, 1932, *43*, 273–300.

Radiotherapy of carinoma of the vulva has given very unsatisfactory results and there are few reports that can be evaluated statistically, for not enough detail has been given in regard to the nature and amount of treatment. The author reviews a number of the cases from the literature and reports 24 cases treated at the University Gynecological Clinic in Vienna. Of these cases 5 are free of symptoms after a year, one after almost three years and one after more than two years.

Carcinoma of the vulva is one of the most difficult forms to treat technically and illustrations are given of different methods of applying radium. Cure or long-continued improvement has been brought about by different methods and none has been uniformly successful, so that no one method can be given decided preference. Evidently various other factors are involved in prognosis. Some uniform method should be adopted of classifying and grouping the cases for statistical purposes; reports should be given of the technique and dosage used in each case, as such detailed reports of large numbers of cases will be necessary before conclusions can be drawn in regard to the best methods of treatment.—*Audrey G. Morgan.*

PHILIPP, E. Statistik der Karzinome des Collum uteri und der vagina aus den Jahren 1923–1925 mit kritischen Bemerkungen zur Therapie. (Statistics of carcinoma of the cervix and vagina for the years 1923–1925, with critical remarks on treatment.) *Strahlentherapie*, 1932, *43*, 102–125.

The author reports the five-year results for the years from 1923–1926 while Bumm was in charge of the Berlin clinic. The later cases after Stoeckel took over the clinic will be reported in another article. Among the 448 cases of cancer of the cervix, 183 were operable, or 40.8 per cent, 85 were borderline cases, or 19 per cent, and 180 were inoperable, or 40.2 per cent. Two of the patients were in such bad condition that they were not treated. Among the 446 that were treated 161 are free of recurrence, or 36 per cent. Among the 183 operable cases 105 are free of recurrence, or 57.3 per cent; of the 85 borderline cases 27, or 31.7 per cent, and of the 178 inoperable cases 29, or 16 per cent. The 131 cases that were operated on were operated by the Wertheim method; of these 109 were operable; 68 of these, or 62 per cent, are cured, 39 dead and 2 not reported; there were 19 borderline cases, 6 of which, or 31.5 per cent, are cured and 13 dead. All of the 3 inoperable patients operated on died.

Irradiation was given in 315 cases. Of these 87 were cured, or 27.6 per cent, 2 are alive with recurrence, 218 have died and 8 have not been reported. Of the 87 who were freed of symptoms all are alive but one; she died in 1928 but carcinoma was not found. Of the cases that were irradiated 74 were operable; of these 37 were cured, or 50 per cent; 66 were borderline cases; of these 21 were cured, or 32 per cent, and 175 were inoperable; of these 29 were cured, or 16.6 per cent. One is living with recurrence, 138 are dead and 7 have not been reported.

Of the 15 cases of cancer of the vagina 3 were operable, one borderline case and 11 inoperable. Two of the operable and one of the inoperable cases were operated on by the Wertheim method. All of these patients died. Twelve were treated by radium irradiation; 3 of these patients are alive and free of recurrence.

In operable cases Wertheim's operation is to be preferred. In borderline and inoperable cases radium irradiation is the treatment of choice. In the operative cases primary mortality has been lowered by systematic use of the virulence test and the late results improved by careful selection of cases. The author is not convinced of the value of prophylactic postoperative irradiation either with radium or

roentgen rays. Operation for carcinoma was not any more serious in pregnant than in non-pregnant women.

Radium therapy alone in the author's cases showed better results than combined roentgen and radium therapy. The best method of radium therapy is to give small doses by the fractional method.—*Audrey G. Morgan.*

Zuppinger, A. Resultate der protrahiert-fraktionierter Röntgentherapie von malignen Tumoren. (Results of protracted fractional roentgen therapy of malignant tumors.) *Strahlentherapie*, 1932, *43*, 701–718.

Twenty cases are reported which were treated by protracted fractional roentgen irradiation for malignant tumors and which have remained free of symptoms for over a year. They included a lympho-epithelial tumor of the epipharynx, a carcinoma simplex solidum of the maxillary sinus, an internal epidermoid carcinoma of the cheek of the skin type, a reticular sarcoma and a lympho-epithelial carcinoma of the tonsils, an epidermoid carcinoma of the base of the tongue of the mucous membrane type, a carcinoma of the vallecula of a semi-epidermoid structure, an epidermoid carcinoma of the skin type of the left lateral cord, three carcinomas of the upper circumference of the larynx, one of skin type and two of mucous membrane type, 4 cases of carcinoma of the sinus pyriformis, all of the mucous membrane type, 2 carcinomas of the vocal cords of the skin type, and one recurrence of a carcinoma of the vocal cords, one lymphosarcoma of the mediastinum and a carcinoma simplex solidum of the parotid.

In 19 of the 20 cases the diagnosis was confirmed histologically. Only 4 of the cases could have been operated on. In all of them a severe multilating operation would have been necessary. The treatment consisted in all cases of protracted fractional irradiation; in 2 cases supplementary radium irradiation was given and in 2 cases a supplementary operation performed.

Doses were given such that at the close of treatment the mucous membrane was covered with an uninterrupted layer of fibrin. The tumors were irradiated from 2 or 3 fields, a dose of 150–200 r being given in from 48 minutes to 2 hours. The chances for cure depend on the extent of the metastases and the primary tumor, the general condition of the patient and the histological structure of the tumor.

The method is indicated in pavement cell tumors of mucous membranes in which operation cannot be used on account of the site of the tumor, where operation is refused by the family or the patient and in which operation would be very mutilating, if histological examination shows that the tumor is radiosensitive. It is not indicated in cases in which less expensive and less time consuming methods can be used.—*Audrey G. Morgan.*

MISCELLANEOUS

Hernaman-Johnson, F. Some experiments in the projection of the sphenoidal sinus through the orbit. *Brit. J. Radiol.*, May, 1932, *5*, 458–459.

The author made roentgenograms of the sphenoidal sinus through the orbit. The central ray enters the base of the occiput and the orbito-meatal line makes an angle of 10° with the horizontal. The roentgenogram is secured by the use of a chin rest and a simple form of steadying support, the patient being seated before a vertical screen. It must be mentioned that the ethmoid cells on the same side are projected in the same region and cannot be separated by this method. In doubtful instances the intraoral method may be used for the differentiation.—*T. Leucutia.*

Bergk, K., and Chantraine, H. Über eine bequeme und zuverlässige Vorrichtung zur Einschaltung der Lungenaufnahmen durch den Herzschlag. (On a convenient and reliable device for taking pulmonary roentgenograms under control of the heart beat.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1932, *45*, 334–339.

There are various procedures permitting the taking of instantaneous roentgenograms of the chest under control of heart action. There are (1) the use of the pulse beat with the aid of a mirror and photocell; (2) the transformation of the heart murmurs into electric energy with the aid of a microphone, and (3) the use of the current respectively of the tension of the heart action.

It is the authors' opinion that the third procedure is the most convenient and reliable. By embodying the principle of this procedure they recently constructed an apparatus which controls the taking of roentgenograms of the chest by the R wave of an electrocardiogram. Two

metal plates are placed, one on the right arm and one on the left thigh, and the clock is so regulated that the instantaneous roentgen exposure is automatically made at the peak of the R wave. Of course through a change of regulation, films can be taken at any phase of the heart action, and in case steroroentgenograms are made, they can be taken at identically the same points of the electrocardiographic curve.

As is known, Cottenot recently constructed a similar apparatus but he made use of the first procedure, that is, of the pulse beat. He applied a blood pressure apparatus on one arm and relays the pulse wave by means of an oscillometer, galvanometer mirror and selenium cell to the starter of the transformer, which then automatically takes the roentgenogram. It is the authors' contention that their method has certain advantages over that of Cottenot inasmuch as the R wave is very much steeper than the wave of the pulse beat, thus eliminating the error due to the time factor.— *T. Leucutia.*

LE PAGE. Rayons durs et temps de pose rapide en téléradiographie pulmonaire. (Hard rays and rapid exposure time in pulmonary teleroentgenography.) *Bull. et mém. Soc. de radiol. méd. de France*, May, 1932, *20*, 253–263.

Considerable controversy has arisen lately on the value of pulmonary roentgenography with exceedingly short exposures by using more penetrating roentgen rays. The author, by making use of this method, worked out a technique which permits the taking of roentgenograms of the chest at a distance of 2 meters, with 0.04 sec. exposure (220 to 240 ma., 115 kv. eff.). Very good roentgenograms were obtained showing excellent contrast and great richness in detail.—*T. Leucutia.*

ZWERG, H. G. Die theoretischen, experimentellen, klinischen und wirtschaftlichen Grundlagen der protrahiert-fraktionierten Röntgenbestrahlung maligner Tumoren. (The theoretical, experimental, clinical and economic principles of protracted fractional roentgen irradiation of malignant tumors.) *Strahlentherapie*, 1932, *43*, 201–248.

The author reviews what is known of the biological action of roentgen rays on normal cells and malignant tumor cells, and the development of the different methods of irradiation up to the protracted fractional technique.

The question of whether the prolongation of the treatment time is as important as the fractionating of the dosage is studied on the basis of animal experiments. The experiments showed that the prolongation of the time is as important as the fractionating. In irradiation of the skin the effects were as good without as with prolongation but this was not true in irradiation of the blood and other tissues. Therefore the individual doses must be prolonged regardless of the added expense.

This method has proved valuable particularly in cancers of the tonsils, pharynx, larynx, tongue and mucous membrane of the cheeks. It is so expensive that only the larger roentgen institutes can use it. Therefore more precise indications for its use must be worked out.—*Audrey G. Morgan.*

CASATI, ANNIBALE. Experimentelle Untersuchungen über die Röntgenwirkung auf das Knochenmark. (Experimental study of the action of roentgen rays on the bone marrow.) *Strahlentherapie*, 1932, *43*, 582–588.

Experimental work is described and illustrated with photomicrographs. After intense roentgen irradiation the bone marrow passes through two phases, a degenerative and a reparative one. In the degenerative phase the bone marrow parenchyma cells have undergone retrograde metamorphosis into connective tissue cells. In the reparative phase they are retransformed into connective tissue cells as can be shown by the demonstration of transition stages. This work shows that roentgen rays do not simply bring about necrosis of cells; they bring about pronounced morphological and functional changes in the cells that cannot at present be explained.—*Audrey G. Morgan.*